
THE TWO SUNS

JÑĀNAPĪṬHA MŪRTIDEVĪ GRANTHAMĀLĀ English Series 5

Published on the Occasion of the Celebration of the 2500th Nirvāṇa of Bhagavān Mahāvīra

COSMOLOGY OLD & NEW

BEING

A Modern Commentary On The Fifth Chapter

OF

TATTVĀRTHĀDHIGAMA SŪTRA

By

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BHARATIYA JNANPITH PUBLICATION

VĪRA NIRVĀṆA SAṀVAT 2501,
VIKRAMA SAṀVAT 2032, 1975 A. D,
First Edition : Price Rs. 18/-

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Published by

BHARATIYA JNANPITH

Head office : B/45-47, Connaught Place, New Delhi-110001.

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Printed at : Modern Printers, K/30, Naveen Shahdara, Delhi-110032

Founded on Phalguna Krishna 9, Vira Sam. 2470, Vikrama Sam. 2000, 18th Feb. 1944

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GENERAL EDITORIAL

The Bharatiya Jnanpith is a pre-eminent academic institute of our country. It has achieved, during the last quarter of a century, quite worthy results in the field of learned publications in Sanskrit, Pāli, Prākrit, Apabhraṁśa, Tamil and Kannada. Most of them are equipped with critical Introductions embodying original researches which shed abundant light on many a neglected branch of Indian literature. The number of such publications included in its Mūrtidevī and Māṇikcand Granthmālās is more than one hundred and fifty. Most of these works are brought to light for the first time, and thus some of them are rescued from oblivion. It has also published in its Lokodaya and Raṣtra Bhārati Series more than three hundred and fifty titles in Hindi comprising almost all literary forms like novels, poems, short stories, essays, travels, biographies, researches and critical estimates etc. Through these literary pursuits, the Jnanpith aims at giving impetus to creative writings in modern Indian languages. By their quality as well as by their appearance, the Jnanpith publications have won approbation and appreciation everywhere.

The Jnanpith gives, every year, an Award to the outstanding literary work in the various recognised languages of India, which is chosen to be the best creative literary writing of the specific period; and its author gets a prize of rupees one lac at a festive function.

The Jnanpith, which is so particular about the publication of ancient Indian literature and also in encouraging the progress of modern Indian literature, cannot but take into account the 2500th Nirvāṇa Mahotsava of Bhagvān Mahāvīra, one of the greatest sons of India and one of the outstanding humanists the civilised world has ever produced. Naturally, the Jnanpith, amongst its various plans to celebrate the occasion, has under-

taken the publication of important works which shed light on the heritage of Mahāvīra. Numerous teachers, authors and dignitaries have enriched the cultural heritage of our country in which Jainism has a significant place. Jain teachers have preached a way of living which has proved beneficial to many, here as well as elsewhere. What Jainism has stood for in the cultural history of our country deserves special study in its various aspects.

The Tattvārtha-sūtra of Umāsvāti or Umāsvāmī is an important Jaina text, almost unique in its character. It is written in Sanskrit, in the Sūtra style and covers almost the entire range of Jaina doctrines. On the one hand, it has proved a focussing point of all that was available in earlier times and, on the other hand, it has been a rich source to be elaborated by numerous commentators during subsequent periods. It has got ten chapters. The first two chapters deal with the theory of knowledge and also elaborate the Jain view of the animate world. Chapters three and four are devoted to Jaina Cosmography. Chapter five is important inasmuch as it deals with the inanimate world, especially Ontology. Chapters six to ten are in a way ethical in contents and, incidentally, deal with the Karma doctrine and the path to Mokṣa, or Liberation.

From the point of view of modern science, the fifth chapter has a special importance, because it deals with some of the concepts which have great relevance in the perspective of modern science. Naturally, years back, Prof. Ghasi Ram Jain, an eminent Professor of Physics, prepared an elaborate commentary on the 5th chapter of the Tattvārtha-sūtra, which was titled as 'Cosmology : Old and New'. It was published first as early as 1942. On the occasion of the Nirvāṇa Mahotsava, he has revised, enlarged and brought up to date his earlier work in conformity with the researches made during the last three decades in the field of Science. This exposion will not only help us to understand Jaina Cosmology in a clearer perspective but also in comparison with the results of the modern science. In Dr. G. R. Jain, we have a distinguished Physicist who has kept himself up to date in his studies. His preface to the New Edition clearly brings out his approach of science in comprehending reality and in the discovery of truth. He has also explained the need of such a comparative study to understand

and appreciate the concepts of our ancestors in this regard, in the hoary past. It is extremely good of Dr. Jain to have given this revised edition for publication to the Bharatiya Jnanpith. The general editors are very thankful to him.

We are grateful to the authorities of the Bharatiya Jnanpith, especially to its enlightened President, Smt. Rama Jain and to its benign Patron, Shriman Sahu Shanti Prasad Jain, for arranging the publication of this work on the occasion of the 2500th Nirvāṇa festival in honour of Bhagavān Mahāvīra. Our thanks are also due to Shri L. C. Jain, who is enthusiastically implementing the scheme of publication undertaken by the Jnanpith.

A. N. Upadhye

2nd April 1975. **Kailashchandra Shastri**

AUTHOR'S PREFACE (FIRST EDITION)

It was late Jain Dharmabhuṣana Brahmachari Sital Prasad who made me write this book and it is indeed very sad that he has not lived to see the publication of it. This late Brahmachari was inspired with the idea of bringing to light the ancient knowledge of the Jains in different branches of science in a language understandable by all. Accordingly, when through his exhortation, the Trustees of the late Rai Bahadur J. L. Jain's Estate asked me to write a modern commentary on the fifth chapter of *Śri Tattvārthādhigama Sūtra* I could not refuse. The work was undertaken in the January of 1937 and was completed by the middle of 1938 but circumstances prevented its publication for about four years.

As has been remarked by Fermor, Asia has not been scientifically asleep during the whole of the several millennia before the introduction of modern science into India by the Europeans. Researches by oriental scholars into the old Sanskrit and Pāli texts are gradually bringing to light the valuable gems of the cultural heritage of India. The Jains and the Buddhist made discoveries of immense value. In fact Dr. N. R. Dhar has attributed the intellectual stagnation in India after the 12th century to the decline of Buddhism under whose ægis science had considerably developed. About the contributions of the Jain thinkers in the field of physics, biology and mathematics very little is known to the intelligent public for want of popular literature on the subject. The present is an humble attempt to put before the English-knowing public the contributions of the Jains in the domain of cosmology and atomic physics. It is not an attempt to seek in ancient texts the substance of modern theories, as some are likely to think, nor is there any attempt to bring by forced, distant and misleading analogies the ancient

discoveries in line with the modern science. The points where the two agree and where they do not have been laid bare.

One is apt to ask: how is the present work going in any way to serve the cause of the Jain religion or of science? My answer is that the present work is only one link in the chain. The Publishers have under contemplation similar commentaries on the subjects of biology, geography, etc., and when the chain is complete the world will know the peculiar merit of the Jain religion that it has treated not only the problems of soul, truth and ahiṁsā in a rational way but that it deals with matter and the physical universe in quite the same manner. With regard to the cause of science, some day some physicist, like our eminent Jain physicist Dr. D. S. Kothari of Delhi University, may take up some prediction of the Jain physics, work it out mathematically and astonish the world. The 'animistic' belief of the Jains that the plants are endowed with life has already been demonstrated wonderfully by late Sir J. C. Bose, F.R.S. Who can say that the development of the mercury-vapour turbines in America is not the outcome of the descriptions of the mercury vapour engines occurring in ancient Jain and Buddhist works like the *Samarāṅgaṇa Sūtradhāra* and *Śilpa Saṁhitā*? It is mentioned in these works that in the Puṣpaka Vimāna of Rāvaṇa a mercury vapour engine was used which, as every student of Physics knows, is far more efficient than a steam or a petrol engine i.e. it does more work for the same consumption of energy. In the time of Rājā Bhoja there was an Aeroplane Factory at Benaras. An Aeroplane was called an Uḍana Khaṭolā at that time. Not only in America, but also in Germany an attempt was made to replace petrol engines by the mercury vapour engines in the æroplanes. The translation of *Sūrya Prajñapti*, a standard Jain work on astronomy, into the German language has elicited high admiration in the West.

We draw the attention of the scientists towards the following facts particularly:

(i) Jainas assert that the size of the universe is fixed (343 cu. Rajjus) whereas the modern cosmologists believe that the universe was in the form of material highly concentrated corresponding to Brahma's golden egg, which began expanding suddenly some five billion years ago and is expanding even today. This expansion of

the universe has been concluded on the basis of feeble red shift of the spectral lines. The red shift of the spectral lines must be attributed to some other cause, not to the expansion of the universe[1].

(ii) Aether, the medium of motion, cannot be eliminated out of the scheme of the universe. It is a non-material medium and all attempts to associate physical properties with it are bound to fail.

(iii) Aether is the seat of a stationary system of waves.

(iv) The Field or the medium of rest, through which the forces of gravitation and electromagnetism operate, is quite a separate reality, non-active and non-material. Its functions cannot be usurped by the Space. It has been confirmed by Einstein's Unified Field theory.

(v) Space without matter and time does not mean void: space is a substance and a reality in itself in which the property of expansion inheres.

(vi) Space and time form a mixed continuum and this four-dimensional continuum forms a finite universe beyond which no particle of matter or energy can travel on account of the absence of æther but beyond this finite universe there is an infinite extension of pure mathematical space.

(vii) The postulate that the space becomes warped in the presence of matter is unnecessary at least in the explanation of a finite universe.

(viii) According to the Jain view, even the modern atom is a molecule (skandha) and something akin to Raman effect would be discovered in the nucleii of atoms some day.

(xi) According to the laws of union of the elementary grains of energy mesons, positive and negative, of different masses are possible.

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1. Zwicky has already given an alternative explanation. According to him when light passes by a large mass such as a star, not only is it deflected but it also deflects the mass to a small extent. Thus it loses energy. According to quantum theory this means a diminution in the frequency of light and hence an increase in the wave-length i.e., the light looks redder or the spectral lines are shifted towards the red.

Many more such ideas will be found dispersed in the main text and in Jain literature in general. For instance, it is mentioned in the *Gommaṭa Sāra* that the shape of a *paramāṇu* is hexagonal[2]. A free Paramāṇu can travel with a maximum velocity of 14 Rajjus per Samaya (the unit of time) i.e. it can shoot from one corner of the universe to the other in one *samaya*, provided it does not meet any collision. This is the maximum velocity possible in Nature just as, according to Einstein, the velocity of light is the limit.

At each successive collision the velocity is reduced. The maximum age of a star is given as a little more than one *palya* ($=4.13\times10^{46}$ years) showing that in the life-cycle of a star there are stages of infancy, puberty, old age and death corresponding to the modern idea of the evolution of a star. The modern view is that a star starts its career in the form of cold cosmic dust, gradually and steadily contracts and heats up to very high temperatures, then flares up as a novæ or a supernovæ giving out enormously bright light, leaves a residue (called a white-dwarf star) which is dark and thus disappears from view.

In the end, the author has great pleasure in thanking Babu Ajit Prasad Jain, M.A., LL.B., of Lucknow, the veteran leader of the Jain Community, for his kind help in reading through the MS and giving valuable suggestions.

We shall be very grateful for pointing out errors and omissions and for giving useful suggestions. Healthy criticism on the subject is invited.

Gwalior. **G. R. Jain**
8th November 1942,
(Lord Mahabir's Nirvana Day).

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2. It should be remembered that no one has yet seen the atom with the eyes. The best microscopes fail in this respect. The atom models proposed by the scientists are as much like an atom as a railway map is like the actual railway it represents.

PREFACE TO THE NEW EDITION

I have great pleasure in placing before the readers the new edition of my book 'COSMOLOGY : OLD & NEW'. It has been thoroughly revised, enlarged and brought up to date in conformity with the researches made during the last three decades since the publication of the first edition in 1942. It has been possible to do so through the kind patronage of Danvir Sahu Shanti Prasad Jain, New Delhi to whom I convey my best compliments. Sahu Shanti Prasad is a leading business magnate and glorious son of Mother India. He has donated huge sums of money amounting to several millions for the uplift of Common man, particularly the Jain society. It is through his generosity and benevolence that thousands of men are earning their livlihood in his mills and factories, some of them holding very high key posts. He is interested in publishing the heritage of Jain culture far and wide. Here I cannot forget to express my deep gratitude to brother Lakshmi Chand Jain of Bharatiya Jnanpith without whose inspiration it would not have been possible to undertake this hard task at the age of 72.

I draw the kind attention of our readers towards the following points:

(i) Jains assert that the size of the universe is fixed (343 cu. Rajjus), whereas the modern cosmologists believe that the universe was in the form of material highly concentrated corresponding to Brahma's golden egg, which began expanding suddenly some five billion years ago and is expanding even today. This expansion of the universe has been concluded on the basis of feeble red shift of the spectral lines.

Shri Deepak Basu of the Institute of Radio Physics, Calcutta published a very learned article in '*Science and Culture*' in April 1964. He wrote as follows:—

"The well-known red shift has been explained recently from Einstein's theory of Relativity as due to gravitational field of the galaxies. In case this theory is accepted the idea of the expansion of universe will be ruled out."

In '*Science Reporter*' for January 1972 on page 28 we read as follows:—

"The red shifts of galaxies are found to be small while those of Quasars[3] are large. The large red shifts of Quasars have been interpreted by astronomers as cosmological red shifts similar to those of distant galaxies, but the view has also been advanced that they are really Einstein shifts resulting from enormously strong gravitational fields at their surfaces. This controversy has continued for a number of years, but a recent study of the Quasar 3C279 by long base-line interferometry *has cast serious doubts on the familiar interpretation* of red shifts and their relationship to cosmological distances. It seems as though the red shift/distance relationship *is going to be thrown overboard*, at least as far as the Quasars are concerned......Therefore it is clear that if the Quasar is at the distance that its red shift implies, the emitters, according to Hubble's formula, would be moving at a speed ten times the speed of light. The next question is: Can a body attain that speed? The answer is obviously, 'No'...The very picture of the universe seems to need a revision".

The above quotations have fully verified that the universe is not expanding and thus the theory of a finite universe of the Jains has been wonderfully confirmed. We wrote in 1937 that the red shift of the spectral lines

3. Quasars are extremely brilliant celestial bodies situated almost at the fringe of the universe wherein matter is very highly concentrated.

must be attributed to some other cause not to the expansion of the universe.

(ii) Aether, the medium of motion, cannot be eliminated out of the scheme of the universe. It is a non-material medium and all attempts to associate physical properties with it are bound to fail. Aether is the seat of a stationary system of waves. These stationary waves are formed by the super position of sinusoidal variations in the properties of the medium. In the language of Jain Śāstras it is called *ṣaḍguṇī hānivṛddhi* and its minutes details are given in the text.

(iii) Science did not believe in the atomicity of space until lately, but now the view is that the space is composed of a huge number of very small (but finite) unit cells which cannot be sub-divided in any way. These unit cells are called *pradeśas* in the language of our Śāstras.

(iv)to(ix) Read page 7 of the Preface to the First Edition.

(x) The existence of nuclear matter follows directly from the definition of pradeśa and in recent years it has been confirmed by the discovery of quasars.

(xi) In the last few years an intensive hunt has been going on all over the world for the search of the 'Ultimate Particle' of matter called Pudgala by the Jains and Quark by the scientists. The Quark is the building block of matter out of which every thing is made.

(xii) Scientists are of opinion that all processes of life can be explained in terms of the laws of physics and chemistry. According to them the proteins, the DNA, and RNA are the substances which govern all activities of life. Hundreds of experiments were performed in America and elsewhere to correlate these substances with consciousness and memory but they badly failed i.e. consciousness could not be explained in terms of physics

and chemistry and hence the existence of soul remains unchallenged (vide Sūtra No. 4).

I offer my profound thanks to Jain-Ratna Seth Shital Prasad of Meerut who took keen interest in the progress of the work from time to time. He has done his best to ameliorate the condition of Jain Samāja.

As I cannot read and write myself owing to bad eye-sight, Shri Mool Chand Jain of C.D.A., Central Command, Meerut did the entire work of preparing the manuscript. I sincerely feel that without his cooperation the book would not have seen the light of the day. I express my deep sense of gratitude towards him. My thanks are also due to Prof. M. L. Pandya, Head of the Physics Department, Modinagar, Miss Rita Jain, Lecturer, Meerut College, Mrs. Abha Jain (M.A.) and Shri Murari Lal Gupta who have helped in several ways.

I shall be very grateful for pointing out errors and omissions and for giving valuable suggestions. Healthy criticism on the subject is invited.

223, Thapar Nagar
Meerut
Dated 2.4.1975.

G. R. Jain

THE PROLOGUE

श्रीजिनेन्द्राय नमः

मंगलाचरणम्

नमो नमः सत्वहितंकराय, वीराय भव्याम्बुजभास्कराय।
अनन्तलोकाय सुरार्चिताय, देवाधिदेवाय नमो जिनाय ॥१॥
स्वदोषशान्त्या विहितात्मशान्तिः शान्तेर्विधाता शरणंगतानाम्।
भूयाद्भव-क्लेश-भयोपशान्त्यै शान्तिर्जिनो मे भगवान् शरण्यः ॥२॥

—*Swāmī Samantabhadra*

I bow to Lord Mahāvira, the great well-wisher of all living beings; the source of joy to the souls of the Universe; the one who is worshipped by all celestials and the lord of gods.

I seek protection of Lord Śāntinātha, the incarnation of Peace on earth, for annihilating all lusts and desires of the flesh. He has obtained the highest equanimity of mind and confers peace on those who lie at His feet.

Authoritative Character of Tattvārtha Sūtra.

The present work is a commentary on the Fifth Chapter of *Tattvārthādhigama Sūtra* of Ācārya Umāswāmi (135-219 A.D.), who was the most famous disciple of the universally worshipped saint, Kunda-Kundācārya. The relationship between Kunda-Kunda and Umāswāmi is established by inscription No. 108 of 1365 Śaka Saṁvat, found at Śravaṇabelgolā in Mysore State.

Shri J. L. Jaini of sacred memory has called *Tattvārtha Sūtra* the Jain Bible. It is held in high esteem by all sects and subsects of Jainism. There is no portion of Jain philosophy which is not embodied in this sacred epitome. Like the *Rāmāyaṇa* of the Hindus or the *Qurāṇa* of the Muslims it is recited every day in the temples and in millions of Jain homes.

SPIRIT OF MODERN SCIENCE

This world of ours is dynamic, not static. it is ever-changing and progressing in a forward or a backward direction. Like the spokes of a wheel the rise and the fall follow in succession. Jain Ācāryas have divided the cycle of time into Utsarpiṇī and Avasarpiṇī, i.e., the time rising and falling with a slow serpentine motion. The rise of the sun to the zenith and its fall again every evening is teaching this great lesson of Nature. The great civilizations of Rome, Greece and Babylonia, which rose to the highest point of glory and are now non-existent, are illustrations in point. The early history of modern science shows that the great scientists like Galileo and Bruno had, in their search for knowledge, to face insults and suffer tortures at the hands of the blind custodians of religion. The times have changed and the present is an age of steam, electricity and electronics. The very section of society, who had done its best to check the development of scientific ideas, is now anxious to verify the principles of its religion in the light of modern investigations.

A word of caution may be sounded at this stage. In order to make a true comparative study of one's religion and the modern science, one should not forget the spirit of the modern scientist. The present tendency is to distort every fact of religious principle so as to bring it in conformity with the theories of science, without knowing that the theories of science are not absolute truths but are ever-changing. The view-point of our study should be to collect those facts to one side which have been verified by the discoveries of science and to put forward boldly before the world those problems which do not agree with the prevalent scientific conceptions and to await solution, if one cannot explain them himself. It is a wrong policy to believe that whatever comes from the West is right; whatever is ours is wrong, although it is true that the westerners make enquiries with impartial views. But since there are limitations to human understanding, the result of enquiries is not always correct.

A present day scientific worker does not work as a Hindu, a Muslim or a Jain. The principle of a particular religion may be confirmed or contradicted by his discoveries, he does not care. He is a meek seeker after truth. Whatever stands the test

of sane logic and is verified by experiment is truth in his eyes.

Science may be defined as the "promotion of natural knowledge," "the pursuit of truth," or "the systematic investigation of the world before us" and its claim to be regarded as such is based on the method which it employs for the search of knowledge. The first step is to ascertain the facts connected with the problem by experimental investigation, for *Science recognizes no authority other than Nature*. The next step is to *classify the facts* in order that their significance may be better appreciated. The third essential step is the formulation of a *theory* or *principle* to explain the facts, because science is emphatically not a catalogue of facts but an attempt to fit them into a rational scheme. It is expected of a theory or a principle that it shall be capable of experimental verification and shall lead to a search for new facts. Thus, the journey is continued ever onwards into new realms of knowledge. The characteristic feature of this method is that it is constantly in touch with experimental facts and that is why science can justly claim to be the pursuit of truth. But *are the theories of science absolute truths*? No, *they are not*.

"*Science is a series of approximations to the truth; at no stage do we claim to have reached finality; any theory is liable to revision in the light of new facts*. . , .This is both the joy and inspiration of science that there appears to be no end to new knowledge with its interest. Each advance yields a more farreaching and interesting picture of the physical world, while at the same time opening up fresh views in the shape of new problems awaiting solution."[1]

Leopold Infeld in *The World in Modern Science* says:

"Scientific theory is an attempt to form a mental picture of the reality which surrounds us. It may embrace either a narrow or wide range of facts and also experimental laws, bringing them into due order. Science is not, however, a collection of laws and a haphazard agglomeration of facts. Theory, to begin with, binds them together with a common idea, and creates a picture of reality from which particular facts follow by a process of logical reasoning. . . .theory is something more; it is a creative

1. A. W. Barton.

agent, a guide to a land of new and unknown phenomena; it shows how to evolve new systems and to discover new laws. It draws its life blood from experiments which confirm its conclusions. Experiments which conflict with its deductions overthrow and destroy it. Experiment is and will always remain the final court of appeal deciding the fate of a theory.

How do theories arise? How is our mental picture of the world which surrounds us formed and developed? Do we obtain at first a rough sketch, a faint outline, which, as we proceed, gains in clearness and firmness and gathers new and bright colours whilst retaining the stamp and character of the original outline? In other words, is the development of a theory merely a process of evolution, or do there occur cataclysms, great revolution, which in a short space of time transform our whole physical outlook?

In the history of scientific development we discern both these processes—the *evolutionary* and the *revolutionary*. Evolution is the outcome of the collective efforts of generations, of the brilliant successes of illustrious men, and of minor but useful labours which serve to amplify our theoretical ideas; it is the gradual building up of the structure of science on foundations which have already been laid. In the course of evolution great ideas grow and mature, theory is freed from assumptions, whose extreme simplicity cramps the theory, the range of facts which the theory covers gradually widens and the originally simple mathematical form of the theory becomes at the same time more complicated and far-reaching.

We shall doubtless never succeed in understanding fully the reality which surrounds us. Nowadays, we are conscious that our feeble efforts and unskilled attempts to grasp the laws of Nature become constantly outstripped by the complexity of the phenomena observed in the world of ours. As a theory develops, there may appear in it some minor flaws which may remain unnoticed in the triumphal progress of the theory, only however, to manifest themselves more clearly and menacingly later on. Difficulties of this kind, disagreement between deductions from the theory and the results of experiment, *inconsistencies* and *even vital contradictions* which cannot be explained away by the theory—these often contain the seeds of fresh developments by making it necessary to enunciate new principles and to re-lay

the foundation of science. *When a theory is frustrated in this manner the ground is prepared for a scientific revolution.* This is nearly the work of one great mind. Such a revolution involves the transfer of problems to a new sphere of investigation, *it forces us to consider the scientific phenomena in a different light,* and it lays a fresh foundation upon which we proceed to build a new and different world of physics."

We give below a typical example to show how the views of science change in time:

"The earth is at rest and the sun moves" was the view of Ptolemy.

"The earth moves and the sun is at rest" was the view advanced by Copernicus. Which of these two statements is correct?

In answer, again quoting from the same work (p. 18) of Leopold Infeld:

"The verdict of classical physics is clear and definite in favour of the second statement (i.e., the Copernican view). Is it perhaps possible, is it conceivable that both propositions may be false? And yet a modern physicist listening to a discussion between supporters of the respective theories of Ptolemy and Copernicus might well be tempted to a sceptical smile. The theory of relativity has introduced a new factor into science and revealed a new aspect of phenomena. *It is now known that the question of deciding between the Copernican view and that of Ptolemy is pointless* and that in fact the propositions of both of them have lost their significance. Whether we say "the earth moves and the sun is at rest" or "the earth is at rest and the sun moves", in either case we are saying something which really conveys nothing. *Copernicus' great discovery is today reduced to the modest statement that in certain cases it is more convenient to relate the motion of heavenly bodies to the solar than to the terrestrial system.*"

The reader should carefully note down the latest viewpoint of science on this ancient puzzle. The Jaina astronomers held the Ptolemaic view with regard to the relative motion between the earth and the sun and until lately, before the advent of Prof.

Einstein's theory of Relativity[2] the Ptolemaic view was regarded as absurd and absolutely foolish. Now it has been proclaimed that the conception of motion of the earth round the sun is only a matter of convenience, rather a matter of mathematical convenience.

Denton expressed a similar view in *Relativity and Commonsense:*

"The relative motion of the members of the solar system may be 'explained' on the older geo-centric mode and on the other introduced by Copernicus. *Both are legitimate and give correct description of the motion* but the Copernican is far the simpler. Around a fixed earth the sun and moon describe almost circular paths but the paths of sun's planets and of their satellites are complex curly lines difficult for the mind to grasp and awkward to deal with in calculation while around a fixed sun the more important paths are almost circular."

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2. Prof. Albert Einstein, born in 1879, has been universally regarded as 'the brainiest man in the world'. He startled the scientists all the world over by his theory of Relativity. The special theory was given in the year 1905 and the general theory of Relativity was published in 1915. One interesting story is told about the explanation of relativity.

Mrs. Einstein did not understand her husband's theories. One day she asked, "What shall I say is Relativity?" The thinker replied with an unexpected parable, "When a man talks to a pretty girl for an hour it seems to him only a minute, but let him sit on a hot stove for only a minute and it is longer than an hour. That is Relativity."

However it is not as simple as that. The theory has brought revolutionary changes in the fundamental concepts of mass, length, time and space; it has supplied a key to the better understanding of the mysteries of the Universe. The size, the mass and the shape of the Universe have been ascertained with the aid of this theory. Here are some of the results:

The mass of the Universe=
21430000000000000000000000000000000000000000000000000000 gms.
(2143 followed by 52 zeroes)

The radius of the Universe=
10100000000000000000000000000 cms. or 1068 million light-years.
(101 followed by 25 zeroes)

One light-year=5865696000,000 miles.

The number of electrons in the Universe=
1290000000000000000000000000000000000000000000000000000000000
0000000000000000000 (total number of digits is 80)

(Electron is the tiniest particle of matter discovered by modern science.)

Again we notice that the assumption of a fixed earth and the moving sun increases the modern mathematician's difficulties; the calculations become awkward to deal with and hence the Copernican view is preferred, not that the older view is incorrect. It is well to remember in this connection the words of Dr. Schubring, of Hamburg University (Germany), which he spoke on the 30th of January 1928 during the course of a lecture delivered at Delhi.

"He who has a thorough knowledge of the structure of the world cannot but admire the inward logic and harmony of Jain ideas. *Hand in hand with the refined cosmographical ideas goes a high standard of astronomy and mathematics.* A history of Indian astronomy is not conceivable without the famous *Sūrya Prajñapti.*"

What conclusion can be drawn from the brief considerations given above. The answer in the words of Leopold Infeld is "that all theories in physics, like human life, have their beginning and their end. In the twentieth century, with its enormous and intensive developments in science, they enjoy for a time the fullness and joy of life, but their life is short. Our mental picture of the universe is constantly undergoing modification and change. Science is ever giving it a new shape. Science is not a structure in which only the ornamental details of secondary importance are changing. Such a picture of it would be not only sad and dreary, but quite wrong. The joys of creative work and the joys of scientific knowledge and of an appreciation of scientific principles and laws lie in their eternal youth and change. *Change is progress, the road upwards leading through error and mistake.* We change or modify theories in order to bring within their ambit an ever wider range of facts and to obtain an ever greater degree of agreement with observation."

The reader may well note the great contrast between the never changing laws of Nature enunciated by the Jain Tirthankaras and the ever changing theories of modern science. In view of this fact it is never wise to reject what at present seems to be contradictory against the theories of science. The science is ever sounding the bell:

"We are beginning to appreciate better, and more thorough-

ly, how great is the range of our ignorance."[3]

"Truth is what the scientist aims at. He finds nothing at rest, nothing enduring, in the universe. Not everything is knowable, still less is predictable. But the mind of man is capable of grasping and understanding at least a part of Creation."[4]

Then there is another important feature introduced in science by the great Theory of Relativity. Einstein has very beautifully differentiated between 'true' and 'really true'. To quote his own words:

"Is it really true that a moving rod becomes shortened in the direction of its motion? It is not altogether easy to give a plain answer. I think we often draw a distinction between what is *true* and what is *really true*. A statement which does not profess to deal with anything except appearances may be *true*;[5] a statement which is not only true but deals with the realities beneath the appearances is *really true*."

According to Einstein, we can know the truth, but not the real truth or absolute truth. The following illustration taken from the domain of physics will make the point clear:

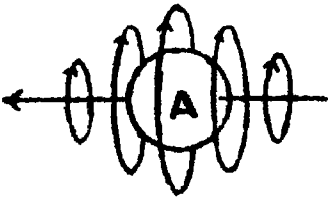
Imagine a stationary conductor charged with electricity placed anywhere upon the surface of the earth. There exists an electric field round a charged conductor. In other words, it means that if any other conductor charged with electricity is brought in the neighbourhood of the former the latter will be attracted or repelled[6] depending upon whether it is charged with the opposite kind of electricity or of the same kind. It is well to bear in mind that there is no magnetic field round a stationary electric charge, i.e., a magnetic compass brought in its neighbourhood would not be deflected by it. But as the earth is in motion round its axis, to an observer situated on a distant planet, the conductor which is stationary *relative* to the earth, will appear to be in motion.

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3. *The World in Modern Science* by Leopold Infeld, p. 60.
4. *The Restless Universe by Max Born*, p. 278.
5. In the terminology of Jaina Scriptures 'True' refers to Vyavahāra Satya and 'Really True' refers to Niścayātmaka Satya.
6. There are two kinds of electric charges, called the positive and the negative, and the rule is:

Two bodies charged with the same kind of electricity repel each other while unlike charges attract each other.

Now we have just said that there is no magnetic field round a stationary electric charge but a charge in motion always gives rise to a magnetic field. (See adjoining figure.) So if the distant observer were to make his measurements on the terrestrial conductor he would find the presence of the magnetic field. It means there is no magnetic field round the conductor relative to the observer on the earth but there is a magnetic field round the same conductor with respect to the stellar observer.



A represents a metal sphere charged with electricity. The arrow indicates its motion. Since moving charge is a sort of electric current, it is shown surrounded by lines of magnetic force.

We arrive at the strange conclusion that the charged conductor is giving rise to and not giving rise to a magnetic field at the same time. What is the absolute truth? Is there a magnetic field round the conductor or is there none? No answer can be given to this question. Einstein says, "We can only know the relative truth, the Real Truth is known only to the Universal Observer." Universal Observer of Einstein is none else but the Almighty (Sarvajña Deva) with infinite powers of knowledge and bliss.

According to Einstein, even the measurement of Space and Time is relative. Says Eddington in the *Nature of the Physical World*:

"A fast moving traveller lives more slowly. His cycle of digestion and fatigue; the development of his body from youth to age; the watch which ticks in his waistcoat pocket; all these must be slowed down in the same ratio. If the speed of his travel is very great, we may find that, whilst the stay-at-home individual has aged 70 years, the traveller has aged one year."

This probably furnishes an explanation of the long age of thousands of years enjoyed by Devas[7] and of the long durations

7. Shri J.L. Jaini, in the *Jaina Hostel Magazine* (Vol. VII, Number 3, page 10) has observed that there is a fixed proportion between the respiration, feeling of hunger and the age of the celestial beings. The food interval is 1,000 years and the respiration one fortnight for every Sāgara of age. The proportion of food interval to respiration is thus, 1 to 24000. He has further observed that if a man lived like a god, we should have a legitimate feeling of hunger only once in the day. A normal person has 18 respirations to the minute, or $18\times60\times24=25920$ in 24 hours, roughly 24,000.

after which hunger is excited within them. It is quite possible that the Vimānas (aeroplanes) in which they live and move are moving with tremendous velocities relatively to us.

Thus we see that the truth investigated by science is relative and not absolute and its theories are ever liable to change. The reader might well ask: "What is the value of science if it does not reveal the reality which surrounds us? How are we to discern, through ever-changing theory, the true outline of the world in which we live?" Remember that science has failed to answer these questions. Again in the words of Leopold Infeld, "What is the use of introducing these great questions of metaphysics into the sphere in which we are only just beginning to appreciate the immense complexity of what are seemingly the simplest phenomena of nature?"

Once again we apprise the reader not to forget the words of Prof. Infeld:

"*Scientific theories arise, develop and perish. They have their span of life, with its successes and triumphs, only to give way later to new ideas and a new outlook.*"[8]

As Sir Rabindranath Tagore, winner of the Nobel Prize, said: "Until I had received an honour from a foreign country, I had received scant admiration from my countrymen", so, we may say, "Until an ancient view receives recognition from a foreign country, it receives scant admiration from its countrymen." This spirit should die and the time is come when we should prove by our independent work the truth of our convictions. The author will consider his life-long labours amply repaid if he succeeds, in some measure, in establishing to demonstrate that this is so, by publishing this commentary on the 5th Chapter of *Tattwārthādhigama Sūtra* by Sri Acharya Umāswāmi, also called Umāswāti, comprising only 42 aphorisms in Sanskrit covering hardly a page of this book.

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8. *The World in Modern Science* by Leopold Infeld, p. 231.

॥ श्रीजिनेन्द्राय नमः ॥

CHAPTER V OF TATTWĀRTHĀDHIGAMA SŪTRA

तत्त्वार्थसूत्रे पंचमोऽध्यायः

(THE CATEGORY OF THE NON-LIVING)

अजीवकाया धर्माधर्माकाशपुद्गलाः ॥१॥

ajīvakāyā dharmādharmākāśa-pudgalāḥ (1)

This Sūtra has got the same version in Digambara and Svetāmbara texts.

The substances of the universe may be divided into two chief categories: Living and Non-living; or Soul and Non-soul.

The Non-living continuum comprises:

Dharma—Medium of motion for soul and matter,

Adharma—Medium of rest for soul and matter,

Ākāśa—Space, and

Pudgala—Matter and Energy, and

Kāla—Time (*enumerated separately in Sūtra* 39.)

In all Jain scriptures dealing with the subject there is a description of these substances. We have in *Dravya-Saṁgraha* by Nemicandra[1] Siddhānta Cakravarti:

अज्जीवो पुण णेओ पुग्गलधम्मो अधम्म आयासं ।
कालो पुग्गल मुत्तो रूवादिगुणो अमुत्ति सेसा हु ॥[2]

(Ajīva comprises of *pudgala*, *dharma*, *adharma*, *ākāśa* and *kāla*. Pudgala has form and qualities and the rest are without form.)

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1. Nemichandra was a great Acharya who lived in the tenth century A.D. He was the preceptor of Rājā Cāmuṇḍa Rāya of Ganga Dynasty of South India and has composed several standard works like *Gommaṭasāra, Trilokasāra, Labdhisāra, Kśapaṇakasāra and Dravya Saṁgraha.*

2. *Dravya Saṁgraha*, 15.

Pañcāstikāya of Shri Kundakundācārya gives the following :—

जीवा पुग्गलकाया धम्माधम्मा तहेव आयासं ।
अत्थितम्हि य णियदा अणण्णमइया अणुमहंता ॥[3]

(Jīvas or souls, Pudgala or matter, Dharma and Adharma, the media of motion and rest and finally Space are called *astikāyas*.)

To quote the same principle from other Digambara Jain works:

धर्माधर्मौ नभः कालः पुद्गलश्चेति पञ्चधा ।
अजीवः कथ्यते सम्यग् जिनैस्तत्त्वार्थदर्शिभिः ॥[4]

or

धर्माधर्मावथाकाशं कालः पुद्गल इत्यपि ।
अजीवः पञ्चधा ज्ञेयो जिनागमविशारदैः ॥[5]

or

अथ पुद्गल एवात्र धर्मोऽधर्मो द्विधा नभः ।
कालश्च पञ्चधैवेत्यजीवतत्त्वं जगौ जिनः ॥[6]

(Lord Jina has described five kinds of *ajīva*, viz , Pudgala, Dharma, Adharma, Ākāśa, and Kāla.)

Also from Svetāmbara Āgama we have the following:—

चत्तारि अत्थिकाया अजीवकाया पण्णत्ता, तंजहा-धम्मत्थिकाए, अधम्मत्थिकाए, आगासत्थिकाए, पोग्गलत्थिकाए ॥[7]

(Amongst the non-living *astikāyas* there are four, Dharma, Adharma, Ākāśa and Pudgala.)

COMMENTARY

अजीवकायाः—"यथा शरीरं पुद्गलद्रव्यप्रचयात्मकं तथा धर्मादिष्वपि प्रदेशप्रचयापेक्षया काया इव काया इति । अजीवाश्च ते कायाश्च अजीवकायाः" ॥[8]

3. Pancāstikāya, 1·4.
4. Dharma Śarmābhyudaya Kāvya, 21·81.
5. Candraprabha Carita, 18·67.
6. Vardhamāna Purāṇa by Bhattāraka Sakalakīrti, 16·15.
7. Sthānāṅga, Sthāna 4, Uddeśaka 1, Sūtra 99; Vyākhyā Prajñapti, Śataka 7, Uddeśaka 10, Sūtra 218.
8. Sarvārtha Siddhi by Pūjyapāda, on Tattwārtha Sūtra 5·1.

Just as the body of any living-being is a conglomeration of matter, in the same way the substances Dharma, Adharma, Ākāśa and Pudgala are a conglomeration of *pradeśas*[9] and may, in this light, be looked upon as possessing body (*kāya*). Hence substances which are non-living and have Kāya are called *Ajīvakāya*.

Astikāya—*asti* means 'exist' and *kāya* means body. Hence an *astikāya* is a substance which has characteristics of existence as well as a body composed of Pradeśas. The substance Kāla (Time), though having the characteristic of existence, is not included amongst the Astikāyas because it does not have many Pradeśas. Astikāyas are five: Jīva, Ajīva, Dharma, Adharma and Ākāśa and these together with Kāla constitute the Six Realities of Jain philosophy.

जावदियं आयासं अविभागीपुग्गलाणुउट्ठद्धं ।
तं खु पदेशं जाणे सव्वाणुट्ठाणदाणरिहं ॥[10]

(Pradeśa is the unit of space occupied by one indivisible atom of matter and capable of being occupied by other fundamental particles.)

In other words, Pradeśa is that elementary cell of Space which one indivisible ultimate atom of matter occupies. In such a Pradeśa of Lokākāśa one Pradeśa of Dharma, one Pradeśa of Adharma, one particle of Kāla and *innumerable atoms of matter or even molecules in a subtle state* may exist.

It is quite reasonable to ask how can an innumerable number

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9. In the *Science Today* for March 1973, Mr. Lawrence Horstman writes about the pradeśa as follows:

"Essentially there is no such thing as an 'infinitesimally small' distance, but that instead space itself is composed of huge number of very small (but finite) unit cells which cannot be subdivided in any way".

These huge number of very small but finite cells which cannot be subdivided in any way are the *pradeśas* of the Jains.

Further, 1965 Nobel Prize winner, Richard Feynman, feels much the same.

Recently the following words were uttered by him during a lecture delivered in America on similar issue:

"I believe that the theory that space is continuous is wrong."

This is again a great triumph of Jaina Siddhānta of which we must be proud. Science did not believe in the atomicity of space until lately.

10. *Dravya Saṅgraha*, 27.

of atoms occupy one cell of space when the unit of space has been defined as the portion of space occupied by a single atom. It is an apparent contradiction in terms. Before we try to explain this beautiful anomaly, let us produce from other sources evidences to corroborate the same view.

Shri Acharya Pūjyapāda writes in the *Sarvārtha Siddhi* as follows:—

"परमाणुः स यावति क्षेत्रे व्यवतिष्ठते, स प्रदेश इति व्यवह्रियते ॥"[11]

It is an assumption that the space occupied by an indivisible particle of matter is called *pradeśa.* (It is a convenient assumption because truly speaking space is a continuous medium but it is broken up into Pradeśas for explaining physical phenomena.)

Further on the same author says:

स्यादेतदसंख्यातप्रदेशो लोकोऽनन्तप्रदेशस्यानन्तानन्तप्रदेशस्य च स्कन्धस्याधिकरणमिति विरोधस्ततो नानन्त्यमिति ॥ नैष दोषः। सूक्ष्मपरिणामावगाहनशक्तियोगात्परमाण्वादयो हि सूक्ष्मभावेन परिणता एकैकस्मिन्नप्याकाशप्रदेशेऽनन्तानन्तानामवस्थानं न विरुद्ध्यते ॥[12]

(How can an infinite number of atoms and molecules—multiple-atomed molecules some of which comprise an infinite number of atoms—be accommodated in space where the number of Pradeśas is only innumerable[13] and not infinite?)

This is the same question which we have raised, worded, of course, in a different language and the author replies: "It is no contradiction." How? "On account of the subtlety and accommodating power of molecules."[14]

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11. Sarvārtha Siddhi, Sūtra, 5·8.

12. *Ibid.* Sūtra, 5·10.

13. Jainism draws a distinction between innumerable and infinite. The former has a limit though it is beyond the power of even an omniscient being to count them, the latter is without limit.

"संख्याविशेषातीतत्वादसंख्येयाः"

"तदनुपलब्धेरसर्वज्ञत्वप्रसंग इति चेन्न, तेनात्मनावसितत्वात्"

(Tattvārtha Rājavārtika, Sūtra 5·8)

14. न एष दोषः। सूक्ष्मपरिणामावगाहनशक्तियोगात्।

(Sarvārtha Siddhi, Sūtra 5·10)

In order to appreciate fully the subtleties of atoms and molecules we shall have to dive deep into the discoveries of modern atomic physics. Before we begin consideration of the model of an atom as conceived by Sir Rutherford, who has been rightly given the name 'Father of Modern Atom', we shall give a brief historical sketch.

"Truth was originally implanted in mankind, but having been suffered gradually to slumber, it was finally forgotten. Since that period, knowledge returns to us as a recollection."—*Lord Kriśna.*

Although the western scholars have no faith in the above doctrine of Indian Kriṣṇa, it is nevertheless a historic fact based on philological[15] evidences that Aryan culture of the East is the most primitive culture known on the surface of the earth. According to the investigations of western scholars Aristotle and Kant who, at one time swayed philosophic thought most powerfully, taught that the space in the Universe is *continually filled* with matter. The first clear exposition of the fact that matter is not continuous but atomic is said to have been given by the Indian Ṛśi Kaṇāda[16] long before the rise of Grecian philosophy. Amongst the Greek philosophers, Democritus of Abodera was the first to put forth the opinion that the world consists of empty space and an infinite number of indivisible, invisibly small atoms and that the appearance and disappearance of bodies was due to the union and separation of atoms. It is well to bear in mind that Democritus lived about the year 420 B.C., when the beautiful realities of the atomic world revealed by Lord Mahāvirā[17] were hardly 100 years old. "According to Max Muller, there are many points in common between the early Greek and Indian philosophers, and there is a *historical possibility* that the Greeks were influenced by Indian thought travelling through Persia."[18]

It is rather unfortunate that Jainas until lately did not give

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15. Vide O. Schrader, *Sprachvergleichungen and Urgeschichte Jena*, 1907; T. Taylor, *The Origin of the Aryans*, London, 1892; F. M. Muller, *Biographies of Words*, and the *Home of the Aryas*, London, 252, 1888.

16. H. T. Colebrooke, *Asiatic Researches of Calcutta*, 5.1.1799.

17. Lord Mahāvīra (598-527 B.C.)

18. Quoted from *A Comprehensive Treatise on Inorganic and Theoretical Chemistry* by J. W. Mellor, D.Sc., p. 22.

opportunity to western scholars to study their literature,[19] otherwise the history of atomic theory of matter would have well extended beyond the time of Kaṇāda and Greek philosophers to the time of Lord Pārśvanātha (842 B.C.), if not beyond it. (Western scholars have come to regard Lord Pārśvanātha as a historical person and founder of Jainism.[20]) The main difficulty in tracing the ancient origin of any fact mentioned in Jain scriptures lies in the fact that the usage of committing to paper was unknown in days of old, the knowledge being transnitted from the teacher to the pupil or from the father to the son orally. The earliest written Digambara Jain works are those of Shri Kundakundācārya (about 100 A.D.) about which it is sometimes said that, although based on the word of Lord Mahāvīra, it is not the śruta literature of his times. The śruta literature was organized and written down by Svetamber saints in the fifth century A.D.

We have referred above to the discovery of atomic nature of matter by Democritus. His views may be summarized as follows:[21]

1. Matter is discrete, not a continuum.[22]

2. All substances are formed of solid atoms which are separated from one another by void space. Each atom is a distinct individual.

3. The atoms are impenetrable, indivisible, and indestructible. They are as perfect, as fresh today as when the world was new.

4. The atoms differ from one another in shape, size and weight.

5. There is a finite number of different kinds of atoms, but an infinite number of homoemetric (of like shape) atoms of each kind.[23]

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19. "Some day when the whole of the Jain Scriptures will have been critically edited and their contents lexically tabulated together with their ancient glosses, they will throw many lights on the dark places of ancient and modern Indian languages and literature."—Dr. Barnett.

20. See *History of the World* by Harmsworth, Vol. II, p. 1198.

21. Quoted from *Comprehensive Treatise on Inorganic and Theoretical Chemistry* by J. W. Mellor.

22. cf. अणवः स्कन्धाश्च (Tattvārtha Sūtra, 5·25)
(Matter is in the form of atoms and molecules.)

23. cf. संख्येयासंख्येयाश्च पुद्गलानाम् (Tattvārtha Sūtra, 5·10.)

6. The properties of all substances depend upon the nature of the constituent atoms and the way the atoms are arranged.

7. The atoms are in constant motion.

8. Combination or aggregation is due to the coalescence of moving particles.[24]

The name of John Dalton (1766-1844) is closely associated with the development of Atomic Theory of Matter in Europe. He was an English chemist, who in 1803 definitely declared that a gas such as air, oxygen, nitrogen, etc., was composed of discrete particles which were in rapid movement and that the size of the particles was small compared to their distances apart.

Modern investigations have shown conclusively that all matter is composed of molecules which, in the case of gases, are travelling in all directions with high speed. Theoretically a piece of chalk may be broken into two pieces, those two into four, and so on to infinity. In reality, matter cannot be subdivided beyond a certain point without losing its identity. The smallest particle into which matter may be subdivided without destroying its characteristic properties is called a molecule (*skandha*)[25]

The *skandha* is described as follows in Pañcāstikāya:

खंधा य खंधदेसा खंधपदेसा य होंति परमाणू ।
इति ते चदुव्वियप्पा पुग्गलकाया मुणेयव्वा ॥
खंधं सयलसमत्थं तस्स दु अद्धं भणंति देसोत्ति ।
अद्धद्धं च पदेसो परमाणू चेव अविभागी ॥[26]

(Matter exists in four main forms : *skandha, skandhadeśa, skandha pradeśa, and paramānu.*)

The complete molecule of matter is *skandha;* a half of it is *skāndhadeśa;* a half of that half is *skandhapradeśa*; and what cannot be divided is the primary atom.)

No one has ever seen a molecule; these particles being so small that even the best microscope fails to reveal them. The diameter of a molecule has been measured to be one ten-millionth

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24. cf. भेदसंघातेभ्य उत्पद्यन्ते (Tattvārtha Sūtra, 5·26.)

25. In the Nyāya and Vaiśeṣika schools of Hindu philosophy also the theory of the atomic structure of matter is found well-developed.

26. Pancāstikāya, 2·80-81.

of an inch $\left(\frac{1}{10,000,000}\text{ in.}\right)$ A drop of water is about one-eighth of an inch (1/8 in.). If it is enlarged five crore times such that its diameter is nearly a hundred miles, the molecules of water within it would appear to have one inch diameter and if the drop were magnified to the size of the earth, the molecules in it would appear about the size of oranges.

The velocity of molecules in a gas varies from one to seven miles per second, while it should be remembered that the velocity of a rifle bullet seldom exceeds half a mile per second. Seven miles per second is such a high velocity that if a body be projected with this velocity from the surface of the earth, it would go beyond the earth's attraction and would never return.

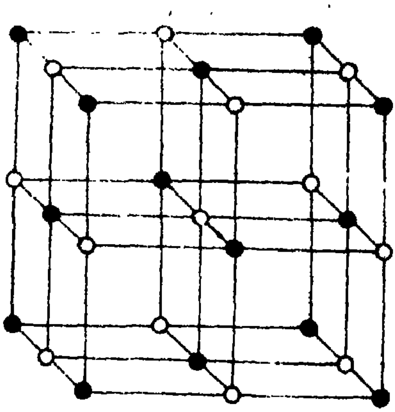
By indirect methods it has been learnt that one cubic inch of air contains 442400000000000000000 molecules. It has been estimated by Prof. Andrade[27] that the number of molecules in one ounce of water is so great that "if every man, woman and child in the world were turned to counting them and counted fast, say five a second, day and night, it would take about 4 million (4000000) years to complete the job".

Although the molecules are so very small, they are not relatively near neighbours; the space between them is much greater than that occupied by the molecules themselves. Within the solids the molecules oscillate to and fro about a mean position. In the liquids they are more free to move and in the gases the agitation is very great. For instance the separation of molecules in steam is about twelve times greater than in liquid water. On account of this greater freedom in gases, the molecules are constantly colliding one against the other, the number of collisions per second being about 6,000 million, i.e., 6,00,00,00,000 times per second. The mean distance travelled between successive collisions has been estimated to be three-millionths $\left(\frac{3}{1,000,000}\right)$ of an inch.

This is the picture of the hurly-burly tumultous dance of molecules within a gas. We shall start to explore the interior of

27. *The Mechanism of Nature* by E.N. da C. Andrade, D.Sc., Ph.D. p. 37.

a molecule now. In a molecule of common salt (See Fig. 1) there are two atoms, one of sodium and the other of chlorine but in a complex molecule like that of alum the number of atoms is about hundred. According to the Jaina view, the material atoms have the capacity of compressing an infinite number of themselves into one molecule. We shall presently bring forth the evidence of modern science in confirmation of this view.



○ Sodium Atom ● Chlorine Atom
A Crystal of Common Salt (Na Cl)
Fig. 1.

When a gas is heated, the molecules within it rush about more vigorously and if the temperature is sufficiently raised, the molecules begin to fall to pieces, i.e., the atoms composing them get separated out just as a cluster of balls glued together would break up under hard impact.

The older view with regard to the atom was that it is like a 'billiard-ball' as hard, unbreakable, and of the same nature all through, like a jelly but this conception of atom was revised by Sir Rutherford. According to him the interior of the atom is a solar system, i.e., an atom is not solid like a billiard-ball but highly porous like the solar system. From a series of difficult experiments Rutherford came to the conclusion that an atom contains within its centre a massive charge of positive electricity[28], with a number of negative electricity particles, called electrons, going round the former with very great velocities in fixed orbits like the planets round the sun. The specifications for the hydrogen atom are given below. The positive charge in the centre is called the proton. See Fig. 2 on page 11.

28. See foot-note No. 6 of the Prologue.

When a dry vulcanite fountain-pen is rubbed with a silken handkerchief, it is observed that rubbed bodies acquire the property of attracting light bodies such as scraps of paper or small feathers. They are said to be charged with electricity. It should be noted that the vulcanite becomes charged with one kind of electricity and silk with the other kind. These two kinds are called arbitrarily as positive and negative.

HYDROGEN ATOM :

Diameter ... $\frac{1}{(200,000,000)}$ inch.

Weight ... $\frac{164}{100,000,000,000,000,000,000,000,0}$ gram.

ELECTRON :

Diameter ... $\frac{1}{500,000,000,000,0}$ inch.

Speed ... 1,300 miles per second.

Weight ... $\frac{1}{2,000}$ of the weight of the hydrogen atom.

PROTON :

Diameter ... about ten times that of the electron.

Weight ... that of the hydrogen atom.

The central positive charge of electricity, the nucleus, has a diameter only about a ten-thousandth of that of the atom and practically all the mass of the atom risides in it. The diameter of an atom is one part out of twenty crore parts of an inch. The lightest atom is that of hydrogen having[29] a mass only one-quadrillionth (1 followed by 24 ciphers) part of one *masha* (gramme) while the mass of an electron is even two-thousandth part of this. The diameter of an electron is five-billionth (1 followed by 12 ciphers is a billion) part of an inch which is about 2,500 millionth part of the diameter of human hair. In an eight-mile molecule the electrons are only 8 inches in diameter. These electrons revolve round the nucleus[30] several quadrillion times per second with a speed of 1,300 miles per second. All these figures tend to show that matter is extremely porous. This porosity of matter was clearly understood by the Jain thinkers several centuries before the Christian era. It is this fact which is expressed by words 'सूक्ष्मपरिणामावगाहनशक्ति' (subtlety and accommodating power of the molecules)[31]. It is interesting to quote in this connection the words of Prof. Eddington, the great Astronomer Royal at Cambridge. He says: "If we elimi-

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29. Hydrogen is the gas which is evolved by dissolving zinc in sulphuric acid and on account of its lightness is used in filling toy balloons and also bigger ones. Water is a compound of hydrogen and oxygen.

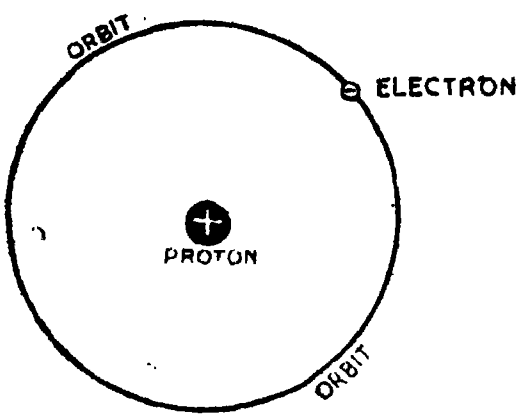
30. The concentrated electric charge in the centre of an atom is called the nucleus.

31. See Footnote No. 14.

nate all the unfilled space in a man's body and collect the nuckeii and electrons into one mass, the man would be reduced to a speck just visible with a magnifying glass."

In order to understand fully how innumerable atoms of matter may be compressed in one unit of space (*pradeśa*[32]), let us proceed a little further and look into the constitutions of atoms as revealed by modern science.

The positive charge of electricity in the centre of the hydrogen atom is called the proton and there is one elementary charge of negative electricity called the electron revolving about this proton in a circular orbit of one 25 millionth part of an inch. (See Fig. 2.) In the same way an atom of helium gas contains



The atom of hydrogen.

Fig. 2

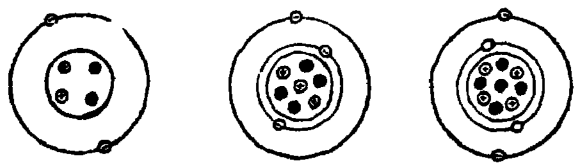
two protons and two neutrons[33] in the centre and two electrons moving round the central nucleus.[34] Then there are atoms with three protons in the centre and three electrons going round and so on, until in the heaviest atom of uranium metal there are 92 protons in the centre and 92 electrons going round them in different orbits. In each case the number of protons is equal to the number of electrons. The atoms of iron, copper, silver,

32. Vide page 4 of this book.

33. A neutron is another fundamental particle consisting of a proton and an electron in very close union with each other. It is a neutral particle without any electrical charge.

34. The nucleus of an atom may consist of one or more number of protons.

and gold consist, respectively, of 26, 29, 47 and 79 protons and electrons each and the number of neutrons are 30, 35, 79 and 118 respectively. In the nuclius, the number of neutrons differs in different atoms. In the nucleii of Helium, Lithium and Beryllium atoms there are respectively 2, 4 and 5 neutrons and so on. In Figure 3 are shown of helium, lithium and beryllium. The sign + refers to the proton and the sign—refers to the electron and the neutron is shown by a small black disc.



Helium. Lithium. Beryllium.

Fig. 3.

The great variety of matter in the universe depends on the fitting together of 92 kinds of atoms to form all manner of structures. These 92 different kinds of atoms consist of 92 different nucleii with corresponding swarms of electrons.

We have just mentioned that on sufficient heating the molecules of matter get broken up into the constituent atoms. The question next arises as to what happens when an atom or atoms are continuously heated to a very high temperature. The temperature within the interior or certain stars is very high, the highest temperature estimated by Eddington being about four crore degree Centigrade. What would be the state of atoms inside these stars? At these high temparatures the atoms begin to lose their outer electrons, i.e., the electrons which compose the body of the atom begin to separate from the atom. Such atoms, in the language of science, are called "ionised" atoms, and the process of separation of the electrons from the atom is called "ionisation". In some case it happens that atoms lose entirely their rings of electrons, the atoms are then called 'stripped' atoms. The theory of stripped atoms has found a beautiful confirmation in the following important and curious astronomical discovery.

Sirius Lubdhaka, which is the brightest star in the heavens, has got a dark companion ten thousand times fainter than itself which was discovered in 1845 by Alvan Clark. From calcula-

tions the mass of the dark companion was found to be one-fourth of Sirius, or $\frac{3}{4}$ of the sun. It has a diameter $\frac{1}{30}$ of the solar diameter and surface temperature 9000 degrees, while the surface temperature of the sun is only 6000 degrees Centigrade. A simple calculation shows that the material of which this star is composed is 2000 times more heavy than the heaviest metal known on earth. An ordinary layman thinks that either gold, mercury, lead or platinum is the heaviest metal. It is true that platinum is the densest metal known on earth but have you ever dreamt that there is somewhere in the universe a metal 2000 times denser than platinum and as to how could it have been formed? What must be the pecularity associated with the atoms of which it is composed? Prof. M. N. Saha, D.Sc., F.R.S., says,[35] "It is apparent that the star consists only of stripped atoms, that is to say, of atoms which have lost some of their outer rings of electrons. This must be due to the high temperature prevailing in the star, but *it is not at all clear* how stripped atoms with a large excess of positive electricity can be so closely packed:[36] because as the charges are of the same sign, the tendency would be for infinite dispersion, instead of abnormal condensation. But such cases of abnormal condensation are not altogether unknown in Physics. The nucleus of atoms consists of a large excess of positive charges *which are somehow packed within a very, very small compass.*"

The last words of the renowned physicist Dr. Saha mean nothing but that an *innumerable number of atoms in a subtle state can occupy one unit of space* (*Pradeśa*). This was the teaching of the Jain Tirthankaras centuries before the advent of modern science.

With regard to this kind of matter, Eddington wrote a few years ago, "One ton (=28 maunds) of such nuclear matter can be easily carried in a waistcoat pocket." But now comes the news that matter even more dense than this has been discovered. Ruby Ta'Bois, F.R.A.S.,[37] says:

"In some of these bodies (small stars) the matter has become so densely packed that a cubic inch weighs a ton. The

35. Presidential address delivered before the *Science Congress*, Bombay in 1926.

36. See Foot-not No. 6 of the Prologue.

37. See *Arm Chair Science*, London, July 1937.

smallest known star discovered recently is so dense that a cubic inch of its material weighs 620 tons."

A piece of matter one inch long, one inch broad, one inch thick has a weight over 17,000 maunds !! Can you dream it ? Can you believe it ? Nevertheless it is a fact. It is the result of subtlety and accommodating power of the molecules (सूक्ष्मपरिणाम-अवगाहन-शक्ति) that innumerable atoms of matter can occupy one Pradeśa. Modern sceptic thinks and wonders whether the phenomenon of packing of stripped atoms was known to ancients. However the fact is there. The definition of Pradeśa is full of significance. We reproduce it once more:

"Pradeśa is the unit of space occupied by one indivisible atom of matter but in which innumerable atoms of matter may exist in a subtle state."

The recent discovery of quasars and pulsars in the last decade has further confirmed this view. These are distant celestial bodies situated almost at the border of the universe wherein matter has been concentrated in an enormously dense manner.

DHARMA

Now we take up the discussion of the next component Dharma in the main Sūtra:

अजीवकाया धर्माधर्माकाशपुद्गला: ॥१॥

Dharma has been defined by the Jaina writers in the following terms :—"गमणणिमित्तं धम्मम्" ॥[38]

(The auxiliary cause of motion is Dharma.)

गइपरिणयाण धम्मो, पुग्गलजीवाण गमणसहयारी ।
तोयं जह मच्छाणं अच्छंताणेव सो णेई ॥[39]

(As water helps the movement of a moving fish so does the medium of Dharma help the motion of matter and soul. But it does not move those which are not moving.)

It should be noted that the word Dharma[40] in the Jain Śāstras

38. Niyama Sāra, 2·30.

39. Dravya Samgraha, 17.

40. "धर्मादय: संज्ञा: सामायिक्य: । आर्हते हि प्रवचनेऽनादिनिधनेऽर्हदादिभि: यथाकालमभिव्यक्तज्ञानदर्शनातिशयप्रकाशैरवद्योतितार्थसारे रूढा एता: संज्ञा ज्ञेया: । क्रियानिमित्ता वा ॥"

has been used in entirely a different technical sense than it is ordinarily understood to mean. Hindu philosophers have used the word in the sense of 'duty' or 'righteous deeds' (यतोऽभ्युदयनिःश्रेयससिद्धिः स धर्मः), but according to the Jaina writers "Dharma" means the Aether of Space, the medium of motion, peculiar although it may seem.

"जीवपुद्गलयोर्धर्म्मः सहकारी गतेर्मतः ।
अमूर्त्तो निष्क्रियो नित्यो मत्स्यानां जलवद्भुवि ॥"[41]

(Dharma is known to assist the motion of soul and matter. It is formless, inactive and eternal. It behaves like water towards the fish in the world.)

क्रियापरिणतानां यः स्वयमेव क्रियावताम् ।
आदधाति सहायत्वं स धर्म्मः परिगीयते ॥
जीवानां पुद्गलानां च कर्त्तव्ये गत्युपग्रहे ।
जलवन्मत्स्यगमने धर्म्मः साधारणाश्रयः ॥[42]

(The medium, which helps the motion of things already in motion, is called Dharma. Just as fish takes the help of water in its movement so do soul and matter take the help of Dharma when they begin to move by themselves.)

"धर्म्मः स तात्त्विकैरुक्तो यो भवेद् गतिकारणम् ।
जीवादीनां पदार्थानां मत्स्यानामुदकं यथा ॥"[43]

(The fulcrum of motion for substances like soul, etc., is called Dharma by the adepts.)

"जलवन्मत्स्ययानस्य तत्र यो गतिकारणम् ।
जीवादीनां पदार्थानां स धर्म्मः परिवर्णितः ॥
लोकाकाशमभिव्याप्य संस्थितो मूर्तिवर्ज्जितः ।
नित्यावस्थितिसंयुक्तः सर्वज्ञज्ञानगोचरः ॥"[44]

41. *Vardhamāna Purāṇa* by Sakalakīrti, 16·29.
42. *Tattvārtha-Sāra* by Amṛtacandra Sūri, 3·33-34.
43. *Dharmaśarmābhyudaya*, 21.83.
44. *Candraprabha Caritam*, 18·69-70.

(That which is the cause of motion of substances like souls is Dharma. It helps motion just as water helps the motion of a fish. It pervades the whole universe (Lokākāśà), is without form and eternal and its true nature is known only to the omniscient''.

In *Pañcāstikāya* of Shri Kundakunda we have the following detailed description of Dharmāstikāya:

धम्मत्थिकायमरसं अवण्णगंधं असद्दमप्फासं ।
लोगागाढं पुट्ठं पिहुलमसंखादियपदेसं ॥
अगुरुलघुगेहिं सया तेहिं अणंतेहिं परिणदं णिच्चं ।
गदिकिरियाजुत्ताणं कारणभूदं सयमकज्जं ॥
उदयं जह मच्छाणं गमणाणुग्गहयरं हवदि लोए ।
तह जीवपुग्गलाणं धम्मं दव्वं वियाणेहि ॥
जादो अलोगलोगो जेसिं सब्भावदो य गमणठिदी ।
दो वि य मया विभत्ता अविभत्ता लोयमेत्ता य ॥
ण य गच्छदि धम्मत्थी गमणं ण करेदि अण्णदवियस्स ।
हवदि गती स प्पसरो जीवाणं पुग्गलाणं च ॥
विज्जदि जेसिं गमणं ठाणं पुण तेसिमेव संभवदि ।
ते सगपरिणामेहिं दु गमणं ठाणं च कुव्वंति ॥[45]

(Dharmāstikāya being a non-corporeal (amūrta) substance has none of the qualities ordinarily associated with matter, i.e., it is devoid of qualities of contact, taste, colour, smell, and sound. It is *a continuous medium* pervading the whole universe (Loka). Although, truly speaking, it is non-atomic in nature, i.e., without grains in its structure, for purposes of practical convenience, it is regarded as made up of a number of units of space, i.e., Pradeśas.

It undergoes an infinite number of modifications of an incorporeal nature[46] and has the characteristic property of persistence through births and deaths, hence it is a real and permanent substance. It remains unchanged by the motion of objects but it conditions the motion of those that can move, matter and life.

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45. Pañcāstikāya. 2.90-92, 94-96.
46. For these modifications read commentary on Sūtra 7.

Exactly as water is indifferent to the movement of fishes, so is the Dharma dravya, itself non-motive, the *sine qua non* of motion of souls and matter.

Dharma and Adharma are the substances with the help of which we can distinguish between the fininite universe and the void beyond it ; these media condition the motion and the state of rest of the bodies. They are uncreated (like Space, Time and Matter) and are co-extensive with Lokākāśa (Universe).

Dharmāstikāya neither moves by itself nor creates motion in other things but it supplies the neceseary means for the motion of living and non-living bodies).

The attributes of Dharmāstikāya are given in Svetāmbara Sūtras as follows :—

धम्मत्थिकाए णं जीवाणं आगमणगमणभासुम्मे समणजोगा वइजोगा कायजोगा जे यावन्ने तहप्पगारा चला भावा सव्वेते धम्मत्थिकाए पवत्तंति । गइलक्खणे णं धम्मत्थिकाए ॥[47]

धम्माधम्मे य दोऽवेए, लोगमित्ता वियाहिया ।
लोगालोगे य आगासे, समए समयखेत्तिए ॥[48]

The Jaina point of view with regard to the media of motion and rest (Dharma and Adharma) is well summarized by Prof. A. Chakravartinayanar, M.A., L.T., Presidency College, Madras, in his English Commentary on Pañcāstikāya. We quote the following from the same work[49]:—

"Motion and rest contemplated in this connection are distinctly physico-mathematical. They should not therefore be interpreted even metaphorically to mean anything more than that connotation. We have to remember the following points:—

1. Dharma and Adharma are Amūrta Dravyas. They have no sense qualities of colour, etc.
2. They are Ajīvas—non-living.
3. They have spatial relation though in themselves Ekapradeśi.
4. They are Niṣkriyas, i.e. Non-active.

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47. *Vyākhyā-prajñapti*, 13·4·481.
48. *Uttarādhyayana Sūtra*, 36·7.
49. Eng. Commentary on *Pañcāstikāya*, p. 96.

5. They are Bahiranga hetu or Udāsīna hetu and not Mukhya hetu.

6. They are non-discrete and continuous.

These are some of the important common qualities emphasised by the Jain thinkers.

The Jain philosopher recognized in the world matter, life and space. But are they enough ? No. *There would be no world. The Atoms and Jīvas may be scattered throughout the infinite space.* Therefore there must be something else besides these three. That something must be able to maitain a coherent system of Jivas and atoms, must have the function of preventing the atoms, from flying about, must limit the boundary of the world of things and persons. For the author distinctly says that without Adharma there would be only chaos; there would be no world. Therefore the Jain thinkers pointed the existence of a fourth entity which binds together things and persons. So the hypothesis of Adharma.

This is something like Newton's gravitation ; but Adharma is slightly different. Its main function is to arrest things but then there is one difficulty. If there were Adharma alone how could there be motion at all in all things ? There would be an eternal paralysis of Reality. To remove this difficulty Dharma had to be posited. The function of Dharma is to guarantee motion within the limits imposed by Adharma. This is the reason for the second hypothesis.

But the trouble is not yet over. If the two exist within a spatial limit one guaranteeing motion and the other rest, then the things in motion must be in motion for ever and things at rest must be there for ever.[50] But our experience is not of that kind. One and the same body has motion or rest; it may move or it may come to stay. Therefore Dharma and Adharma must be deprived of their causality. They can only be Bahiranga-

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50. (Foot-note is ours) Sir Issac Newton, the great scientific genius of the West (1642-1727 A.D.), enunciated his first law of motion as follows:

"Everybody continues in its state of rest or uniform motion in a straight line, except in so far as it may be compelled to change that by impressed forces."

"Material frictions and reactions are visible as absolute interferences which can change the motion of a body."

(*The Nature of the Physical World*, by Eddington.)

hetu or Udāsīna-hetu, i.e. they must be indifferent and neutral in themselves and yet must be indispensable to the composition of the world.

This seems to be the logical development of the system. The most approximate modern conception answering to the description will be Ether of the physicist. But the Jaina systems require two such entities functionally different; one acting like Newton's gravitation (Adharma) and the other guaranteeing motion within the limits. It would not be quite accurate to think of centripetal or centrifugal forces, because Dharma and Adharma are Niṣkriyas. Does it mean the duality of electro-magnetic influence of Ether? The constitution of an atom is supposed to be a system of electrons (positive and negative).[51] Had the Jain thinkers any such idea about the whole world? We can only contemplate. But of this much we are certain that Dharma and Adharma are parts of the physical system. They are two different entities *without which the System of reality would be impossible and incomplete*".

Let us see what has a physicist to say about his aether.

In a popular scientific work *An Outline for Boys and Girls and Their Parents* we find the following:

"The first problem was, of course, that if light waves were real waves, they must be waves in *something*. They were plainly not waves in matter; it was necessary therefore to invent something else, *which was not matter*, for them to be waves in. This something they called the 'ether', and imagined it as an utterly thin and utterly elastic fluid, that flowed undisturbed between the particles of the material universe and filled all 'empty space' of every kind.

What was this ether like?[52] Difficulties and contradictions appeared at once.[53] For it was proved to be: (1) thinner than the thinnest gas; (2) more rigid than steel; (3) absolutely

51. This slightly erroneous, positive electron is not the proton. Proton is 2,000 times heavier than the positive electron discovered in 1932.

52. Material media are penetrated by ether, their molecules being surrounded by it much as the leaves of a tree are surrounded by air.

53. "A serious difficulty arises at this point. It is difficult to imagine the planets as moving with their enormous velocities through (ether) a jelly-like substance without any loss of energy. The motions of the planets are perfectly regular and show no signs of any loss of this kind."

(Edwin Edser in "*Light*.")

the same everywhere ; (4) absolutely weightless ; and (5) in the neighbourhood of any electron, immensely heavier than lead."[54]

Again we have from F. M. Denton's *Relativity and Commonsense* :

"The Newtonian ether is rigid, yet allows all matter to move about it without friction or resistance ; it is elastic but cannot be distorted : it moves but its motion cannot be detected ; it exerts force on matter but matter exerts no force on it ; it has no mass nor has it any parts which can be identified ; it is said to be at rest relatively to the 'fixed stars,' yet the stars are known to be in motion relatively to one another."

In the *Restless Universe* by Max Born, we read :

"A hundred years ago the ether was regarded as an elastic body, something like a jelly, but much stiffer and lighter, so that it could vibrate extremely rapidly. But a great many phenomena, culminating in the Michelson experiment and the theory of Relativity, showed that the ether must be something very different from ordinary terrestrial substances.

"Now an ether is also required for electricity and magnetism ;................."[55]

Again from The *Nature of the Physical World* by A. S. Eddington, the great authority on the subject, we have :

"This does not mean that the æther is abolished. We need an æther...........In the last century it was widely believed that æther was a kind of matter, having properties such as mass, rigidity, motion like ordinary matter. It would be difficult to say when this view died out......*Nowadays it is agreed that æther is not a kind of matter. Being non-material, its properties are sui generis* (quite unique)[56]...........Characters such as mass and rigidity which we meet with in matter will neutrally be absent in æther but æther will have new and definite characters of its own...........non-material ocean of æther."[57]

Although the scientists have firmly come to believe æther as non-material, their attempts to defect it are not yet over. The most ingenious and well-known experiment devised to detect

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54. *An Outline for Boys and Girls and Their Parents* edited by Naomi Mitchison, p. 314.

55. *Restless Universe* by Max Born, published in 1935; p. 115.

56. This is a brilliant confirmation of Jaina view.

57. *Nature of the Physical World* by A. S. Eddington, p. 31.

æther was performed some fifty-five years ago and is known as the Michelson-Morley Experiment.

The idea of the experiment is this: if all material bodies are really swimming through a limitless ocean of æther, it is quite easy to find how fast they are moving through it. The following analogy will make the point clear: The time taken to row a boat a certain distance up a swift river and down again is always greater than the time taken to row the same distance across the river and back.[58] Even if water were invisible one could calculate how fast it was flowing by measuring the time either way. In the same way it was argued that if earth were really moving through æther a ray of light would take a longer time to go to a mirror and return a certain distance along the earth's motion than *across* it.

If æther were a material medium for the earth to move through, this seemed bound to be so. The experiment was performed in America by means of the most delicate apparatus and, to the great disappointment of the workers, it was found that both journeys of the ray of light took exactly the *same* time. In the words of Richard Hughes: "It showed that to try seriously to find out facts about the æther, as if it were a *real thing*, would be almost as absurd as to try and find out what wood the Good Shepherd's crook is made of !"

The above experiment was performed in 1881 and in 1905 the experiment was repeated with better precautions. The result was published in the Proceedings of the *American Academy of Arts and Sciences*, the result again being zero. During the period 1921-25 a series of more exhaustive and elaborate experiments were carried out by Prof. D. Miller on Mount Wilson, California. Five thousand observations were recorded for full periods of 24 hours and extending over ten days.[59] The final conclusions were that there was a relative motion of the earth and the æther.

This result produced a great commotion in the scientific world for Michelson-Morley Experiment led us to conclude that either there was no material æther or that it moves with the earth or that it is at rest in space, while Miller's work indicated

58. This fact can be proved mathematically.

59. It is well to note from this the great zeal and assiduity which these western workers evince in the search after truth. Read carefully their attempts to detect by experiments the Dharma Dravya.

æther drag and proved æther to be not non-existent.

More delicate experiments were taken up in Germany in the year 1925 by Tomaschek to detect the motion reported by Miller. The work of Tomaschek was again criticised by Chose in America and he carried out his experiments, published in the *Physical Review*, August 1926, but no such motion could be detected. The Michelson experiment has been again repeated in recent years in a free balloon at heights of nearly 1½ and 3 miles but the authors report that they are unable to confirm or refute the Miller's report. That Miller's results are for some reason inaccurate appears to have been established by the research of Kennedy in U.S.A. published in November 1926. The famous 'Chicago rotation experiment' designed to rest the effect of the earth's rotation on the velocity of light confirmed the view that *æther was stagnant not moving.*

The physicists have sometimes become very much confused over the æther controversy. In the words of N. M. Baligh, A.R.C.Sc., A.I.C.: "If an æther does exist it would be a four-dimensional concept and its absolute nature would be just as impossible of comprehension as the function which it serves."

Let us review the whole situation. Why were the scientists led to such absurd conclusions that æther was thinner than the thinnest gas and at the same time more rigid than steel; absolutely weightless and at the same time heavier than lead? The answer is: because they then regarded æther as a sort of matter, i.e., they identified Dharma Dravya with Pudgala Dravya; and the discrepancies have now disappeared, when they have come to regard it as a non-material amūrtika medium. Remember the latest utterance of A. S. Eddington, M.A., LL.D., D.Sc., F.R.S. (Plumian Professor of Astronomy in the University of Cambridge): "*Nowadays it is agreed that æther is not a kind of matter.*"

Why was the Michelson-Morley experiment performed and repeatedly performed with such great refinements? (To find out whether the ocean of æther was moving or stagnant. And what is the latest pronouncement on the subject?) D. C. Miller in his paper '*Ether-drift experiment and determination of the absolute motion of the earth*'[60] says:

60. This research paper was read before The British Association, Leicester, September 1933, and published in The *Nature*, February 3, 1934.

"The magnitude and direction of the observed effect vary in the manner required by the assumption that the earth is moving through a fixed æther."[61]

There should be no surprise in the manner in which the scientists have arrived at this conclusion. As we have remarked several times in the *Prologue*, we cite once more the words of A. D. Rikhie: "Scientific men are bound to be revolutionary; to scrap ruthelessly whatever theory is found to contradict facts, and adopt a new one."

So we see that on the basis of the latest scientific evidences two points are well-established. Dharma Dravya, the Aether is non-material, filling all space and not moving.

Compare with this the Jain version:

अमूर्तो निष्क्रियो नित्यो मत्स्यानां जलवद् भुवि ॥

(Dharma Dravya is *formless*, *inactive* and *eternal*. It behaves like water towards the fish in the world.)

Some people think that with the advent of the theory of Relativity, the æther has been thrown out of science. They should carefully note what the great exponent of Relativity, Prof. Eddington, has to say on this point: "This does not mean that the æther is abolished. We need an æther." (See foot-note No. 57). Thus it is proved that Science and Jain physics agree absolutely in so far as they call Dharma (Aether) non-material, non-atomic, non-discrete, continuous, co-extensive with space, indivisible and as a necessary medium for motion and one which does not itself move.

ADHARMA

Let us now take up the next entity in the Sūtra, viz., Adharma.

"अधम्मं ठिदि जीवपुग्गलाणं च ।"

(अधर्म्मः स्थितेः जीवपुद्गलानां च)[62]

(Adharma is the auxiliary cause of rest to soul and matter.)

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61. This is further supported by the papers published in the *Physical Review* (American), February 15, 1935. (*See* Discussion on Aether-drag by Cartmel.).

62. *Niyama Sāra*, 2·30.

"स्थितिपरिणामिनां जीवपुद्गलानां स्थित्युपग्रहे कर्त्तव्ये अधर्मास्तिकाय: ।"[63]

(The principle which guarantees the permanance of world structure is called the Adharma.)

From *Dravya Saṃgraha*, we have:—

ठाणजुदाण अधम्मो पुग्गलजीवाण ठाणसहयारी ।
छाया जह पहियाणं गच्छंता णेव सो धरई ॥[64]

(Adharma Dravya assists the staying of soul and matter *which are stationary* just as the shade of a tree helps the staying of the travellers. But Adharma *does not stay those which are moving.*)

"छायेव धर्मतप्तानाम् अश्वादीनामिव क्षितिः ।
द्रव्याणां पुद्गलादीनामधर्मः स्थितिकारणम् ॥"[65]

(Adharma is the cause of rest of various substances just as the shade of a tree is the cause of staying of persons heated by solar rays or as the earth is the cause of staying of creatures like horses, etc.)

"द्रव्याणां पुद्गलादीनामधर्मः स्थितिकारणम् ।
लोकेऽभिव्यापकत्वादिधर्मोऽधर्मोऽपि धर्मवत् ॥"[66]

(Adharma is the cause of rest of matter and other substances. Adharma, like Dharma, pervades all universe (Lokākāśa)[67] and has other characteristics similar to Dharma.)

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63. *Sarvārtha Siddhi* on Tattvārtha Sūtra 5·17.

64. *Dravya Saṃgraha*, 18

65. *Dharma Śarmābhyudaya*, 21·84.

66. *Candraprabha-Caritam*, 18.71.

67. The Jain thinkers have divided the universe into two parts, Lokākāśa and Alokākāśa. In the former the substances Dharma and Adharma permeate and hence in this region bodies move and come to rest; in the latter these media of motion and rest are absent; it is all pure infinite space beyond Lokākāśa.

The beautiful scientific exposition of these two regions is given later in this book.

This idea is expressed in the following Gāthā from *Triloka Sāra*:

धर्माधर्माकाशा गतिरागतिर्जीवपुद्गलयोश्च ।
यावत्तावल्लोक आकाशमतः परमनन्तम् ॥

(Sanskrit rendering of 5th gāthā)

"नित्योऽमूर्तः क्रियाहीनश्छायेव पथिकांगिनाम् ।।"[68]

i.e. Adharma, like Dharma, is without form, inactive and eternal; (it is the auxiliary cause of rest to soul and matter) as is the shade of a tree the auxiliary cause of rest for the travellers.

From *Pañcāstikāya* we have:—

जह हवदि धम्मदव्वं तह तं जाणेह दव्वमधम्मक्खं ।
ठिदिकिरियाजुत्ताणं कारणभूदं तु पुढवीव ।।[69]

(The nature of Adharma Dravya is fundamentally the same as that of Dharma. But as the earth is the resting place of objects, so is the presence of Adharma Dravya an indispensable condition for the rest of things in motion, whether they are animate or inanimate.)

Also from Swetāmbara Sūtra Vyākhyā Prajñapti we read:

"अधम्मत्थिकाए णं भंते जीवाणं किं पवत्तति ? गोयमा ! अधम्मत्थिकाए णं जीवाणं ठाणनिसीयणतुयट्टणमणस्स य एगत्तीभाव-करणता जे यावण्णे तहप्पगारा थिरा भावा सव्वे ते अधम्मत्थिकाये पवत्तंति । ठाणलक्खणे णं अधम्मत्थिकाए ।"[70]

This expresses the same conception of Adharma as in the Digambara versions.

To summarise, Adharma Dravya is a non-living, formless, inactive, continuous medium without which equilibrium in the universe would have been impossible. In the absence of which the souls and the atoms would have become scattered in infinite space, that is called Adharma by Jainacharyas. It is the binding force which is responsible for a stable universe; without it there would be chaos and no cosmos.

In the words of Prof. A Chakravarti :—

"The Jain thinker pertinently asks the question why the atoms should be kept together constituting the world of Mahā Skandha ? Why should they not get dissipated throughout Anantākāśa or infinite space ? Then there would be no world. The very fact that the structure of the world is permanent, that

68. *Vardhamāna-Purāṇa*, 16:30.
69. Pañcāstikāya, 93.
70. Vyākhyā Prajñapti, 13·4·57.

the world is a cosmos and not a chaos implies the existence of another principle which guarantees the permanency of world's structure and world form. This principle has the function of binding the flying atoms to the world's centre. Its function is then distinctly inhibitive to arrest the flying atoms. This physical principle is called Adharma or rest...

"Both Dharma and Adharma pervade through space up to world limit. They are absolutely non-physical in nature and non-atomic and non-discrete in structure. The qualities of Pudgala are not found therein. Nor have they the structure of space which is constituted by space points. These two physical principles are perfectly simple. Therefore they may be spoken of as one or as many. They are spacial and yet are non-spacial. They are Amūrta and Arūpa. They are neither light nor heavy. They are not objects of sense perception. Their existence is inferred only through their function. Such are the characteristics of these two principles which are distinctly peculiar to Jaina Physics."[71]

It is a fact worthy of notice that although all Indian philosophies have devoted very great pains to the theorics of world evolution, none of them but the Jains could think of these vital principles of motion and rest without which a stable world structure is not possible.

Let us now try to investigate the modern scientific equivalent of the principle of Adharma as we have proved in the foregoing pages the luminiferous æther to be the equivalent of Dharma Dravya. Apparently the cementing force in the world is what science calls 'GRAVITATION'.

Although the law of gravitation has been styled the most extensive generalisation to which the human intellect has ever attained, Isaac Newton, the discoverer of the law, did not quite understand it. In his '*Letters to Bentley*' Newton wrote:

"You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider it......

"Gravity must be caused by some agent acting constantly according to certain laws; but this agent be material or *non-*

71. Philosophical Introduction to Pañcāstikāyasāra, p. XXVI-XXVII.

material I have left to the consideration of my readers".

It is worthy of note that Newton himself hit at the truth when he suspected that the real cause of gravitation may be a non-material agency. In the foregoing pages we have pointed out clearly that Jain metaphysics regards the medium of rest (the gravitation) as non-material. We shall presently see that the Einsteinian view of gravitation regards the cause of gravitation as passive and non-material (अमूर्तः क्रियाहीनः).

The Newtonian view of gravitation can be gathered from the following considerations : All bodies with which we are acquainted, when raised into the air and quietly abandoned, descend to the earth's surface. They are urged thereto by a force or effort, which, "although it is beyond our power to trace"[72], we call gravity. According to the law of gravitation[73] every particle of matter pulls every other particle directly as the product of their masses and inversely as the square of the distance between them, i.e., the heavier the bodies are, the greater is the mutual force of attraction between them and greater the separation, the smaller is the force of attraction; if the distance between them is doubled, the force of attraction would become one-fourth; if the distance is trebled, the force would become one-ninth and so on.

It was the genius of Newton to extend the law of gravitation from the earth to the heavenly bodies. He came early to suspect that the force which keeps the moon in her orbit is none other than the power of attraction of the earth. After years of waiting, trying and experimenting he proved mathematically the truth of his conviction. Leopold Infeld says[74] :

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72. *Outline of Astronomy* by Sir John. F. W. Herschel, Bart. K. H. on page 265.

73. Although the law of gravitation is associated with the name of Sir Isaac Newton (1642-1727), the Prince of Philosophers, it was already known to the great Indian Astronomers, Bhāskarācārya (Author of *Sūrya Siddhānta*) some 600 years before Newton. Bhāskara enunciated the law exactly in the same mathematical form as did Newton.

Note:—The gravitational attraction between bodies changes into a repulsion when the distance between bodies is extremely small or extremely large.

74. Vide *The World in Modern Science*, p. 65.

"Newton was the first to appreciate that the fall of bodies, the motion of the moon round the earth, the motion of planets relatively to the sun, are all governed by a single general law of gravitation......

"All bodies mutually attract each other. Take a single case that of two homogeneous spheres. The law of gravitation tells us the direction of the attraction between these spheres and what physical factors determine its force. The direction is that of the straight line which joins the centres of the spheres; the force of the attraction depends only on the masses of the spheres and on the distance which separates their centres. Let us double the mass of one sphere and treble that of the other. The force of attraction will be increased 2×3,—that is, six times. Put more briefly and generally :

The force of attraction of two bodies varies directly as the product of their masses. Next assume that the masses of the spheres remain the same but that the distance is trebled. The force of attraction is now reduced by 3×3 times,...i.e., nine times. In other words, the force varies inversely as the square of the distance.

But how is it that this force does not menifest itself in connection with objects which surround us ? Why do not chairs, tables, houses tend to move towards each other ? The answer is simple : The forces of attraction are extremely small; in the case of objects around us they are insufficient to overcome the forces of resistance to motion...that is to say, the forces of friction...which are always brought into play. If the attracting bodies are very massive, the forces of attraction become appreciable. It is due to them that the earth attracts the bodies in its vicinity and the planets move around the sun and the moon moves around the earth.

Yet another question suggests itself in this connection. If bodies attract each other along the straight lines which join them, how is that the earth does not fall upon the sun and the moon upon the earth ? The principles of Newtonian dynamics supply the answer to this question. The direction of motion is *not* that of the direction of the force. When a stone drops freely from a height, it falls vertically towards the earth's centre. A projectile discharged from a heavy gun, however, describes a parabola, although, here too, the force of gravitation acting

upon it is towards the earth's centre. If *we could impart to the projectiles a sufficiently great velocity, we could make them move round the earth as does the moon.*"

Newton extended the concept of gravitation to molecules and atoms also. The propensity of two bodies to react chemically was attributed to the attraction of the particles of one for the particles of the other. Later on the term attraction was changed to affinity. The Greek philosopher Democritus[75] held the view "that the atoms are attracted to one another on account of their whirling motions".

These considerations lead us to the conclusion that gravitation is the cause of the stability of the macroscopic as well as microscopic systems of the universe. But the gravitation, there would be all chaos, there would be no world. The atoms[76] would be scattered throughout space; the galaxies would disperse; the members of the solar system would be torn off one from the other. Hence the necessity of the important postulate of Adharma Dravya, the gravitation.

It should be borne in mind that Newton regarded the force of gravity as an active force, although acting like an invisible agency. The modification of the concept of gravitation introduced by the author of Relativity, Prof. Albert Einstein, renders gravitation quite inactive and thus brings it on the same level as the Adharma Dravya of the Jain philosophers.

The view of Einstein can be approached in the following manner : Suppose this room is a lift[77]; the support breaks and down we go with ever-increasing velocity, falling freely like a stone. Suppose I am inside the lift and I perform the experi-

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75. *A Comprehensive Treatise on Inorganic and Theoretical Chemistry* by J. W. Mellor; p. 785.

76. We have pointed out that the earth moves round the sun because of gravitational attraction. In the case of atoms, however, gravitational attraction plays no real part. The masses of electrons and protons are too small for that. On the other hand, here there is an incomparably greater electric force, i.e., the force of attraction between the positive electric charge of the proton and negative electric charge of the electron. (*see* Foot-note on p. VI of *Prologue*.) However the law which governs this attraction is exactly similar in form to the law of gravitation, so that it is merely a change of name. It is again a force of attraction which keeps an electron moving round the proton.

77. Lifts, electric or hydraulic, are fitted in various buildings, railway platforms, etc., for going from one storey to the other.

ment of dropping an apple held in my hand. Remember that the lift and all things contained in it are falling freely all the while. To my surprise I shall see that the apple cannot fall any more than it is already doing owing to the free fall of the lift. The apple remains poised in my hand. *The force which causes apples to fall, i.e. gravitation as an active agent, disappears,* so far as the man in the lift is concerned.

How ignorant science is of the ultimate nature of gravitation is prettily set forth in a story told by Einstein, as a preliminary to a popular exposition. "Suppose", he says, "that a man were put into a perfectly dark cage that was poised, motionless, far out into inter-stellar space. The man would not weigh anything, he could move from one side of the cage to the other, or from top to bottom, by the slightest push; he could float in the middle of the cage without touching it. Suppose that, unknown to him, a cable were attached to the top of the cage and some strong motive force applied to the cable; suppose that this force drew the cage swiftly in the direction of a line from the bottom to the top of the cage; and suppose that the force were so steady and noiseless that it was not suspected by the man in the cage. What would he imagine was happening ? He would suddenly discover that he was being drawn against the bottom of the cage; only by a strong effort with his legs could he jump away from the bottom for a moment, and then he would instantly feel strongly 'attracted' back to the bottom. Actually, as we can see from outside, the bottom is being drawn towards him; but he, accustomed to his notion of gravitation would never suspect this. He would feel 'attracted by the bottom'. And the most ingenious physicist, supplied with all the most sensitive apparatus, even if he guessed at two reasons for the sensation, could never determine which was the real one."

In the words of Henshaw Ward "Gravitation is an absolute mystery. We cannot guess at any explanation of its nature. If we call it a 'a force of attraction'[78] we are not saying anything ; we cannot conceive how a force can act at a distance

78. Newton introduced the idea of 'gravitation as a force of attraction' because the state of rest or of uniform motion, which he postulated (*see* Foot-note No. 50), cannot be observed in the space in which we live. In the Lokākāśa there is no space devoid of forces.

without any medium through which to act or how the force can act instantaneously or what could propagate it."

But then what is the Einsteinian explanation of falling bodies. According to Einstein the totality of space is so 'curved' that ray of light, after travelling in a direct line for a long enough time, would come back to its starting point. The curving of space in any region depends upon the concentration of matter there ; the greater the mass of matter the greater is the curvature or warping. If anyone could become familiar with the abstruse formulæ and calculations of Prof. Eddington it would be natural to suppose that space and time must be warped under the influence of so much gravitational force assembled in one place. How could it be otherwise ? How could space and time be expected to stand the strain of such an *intolerable deal* of matter heaped around one centre ? In the words of H. Ward again "To be surprised at the curving of space is to be like a child who is grieved when a house of cards crumbles under the weight of a big doll. Certainly space and time must be distorted by gravitation." Why does an apple fall to the earth ? The answer is : the presence of the apple distorts the space in its neighbourhood and the apple then slips along the line of the greatest slope, not that it is pulled by the gravitational attraction of the earth.

Nikhil Ranjan Sen, D.Sc. (Cal.), Ph.D. (Berlin), Professor of Applied Mathematics, Calcutta University, in his article on Relativity[79] writes as follows :

"Though the general theory of Relativity gives a conception of the Universe totally different from the one on which the classical mechanics of Newton and Galileo is based, the new theory succeeds in describing all physical phenomena in conformity with our experience quite as good as the classical theory. With Newton's mechanics gravitation is simply a question of attraction at a distance according to a definite law. How this mechanism of action at a distance operates, the theory is silent about the point[80]. Einstein's theory discards the idea of action

79. Published in the ***Proceedings of the Physics Seminar***, Allahabad University, July, 1925.

80. If we accept the Jain view, the point becomes quite clear. It is the all-pervading invisible medium of rest Adharma through which gravitation makes itself felt.

at a distance and shifts the entire consideration to a totally different ground. The cause of interaction between bodies, according to the new theory, is to be sought in the peculiar nature of the space which surrounds the bodies. *The presence of matter gives an appreciable curvature to the surrounding space and the matter falls down*, as it were *along the slope of this curvature* according to some definite law..............In Einstein's mechanics, the law remains essentially the same though it is formulated in a more rigorous form out of necessity."

Although the scientists have not come to postulate in clear terms the existence of a separate medium of rest,[81] like æther the medium of motion, they are constantly feeling the necessity of it. They do require a medium for the propagation or gravitation. Hence wrote Henshaw Ward : "We cannot conceive how a force can act at a distance *without any medium through which to act* or how the force can act instantaneously or what

81. The nearest approach to the idea of the medium of rest is the field concept which has been developed by Einstein and others in the name of the Unified Field Theory of gravitation and electromagnetism. The field did not exist for the physicist of early years of the 19th century. For him only matter and its changes were real. But the field concept has grown steadily and matter is being overshadowed by the field. Modern science recognizes two realities: Matter and field. In the words of Einstein and Infeld "the electromagnetic field is, for the modern physicist, as real as the chair on which he sits." To quote the same authors further: "A new concept appears in physics, the most important invention since Newton's time: the field. It needed great scientific imagination to realize that it is not the charges nor the particles but the field in the space between the charges and the particles which is essential for the description of physical phenomena." This 'field' is in fact the medium through which the binding forces of gravitation and electromagnetism operate and keep the microscopic as well as macroscopic world together.

Every peice of matter is a conglomeration of atoms and every atom is a compound of protons and electrons. Since the masses of electrons and protons are extremely small the gravitational attraction between them is negligible. It is the forces of electromagnetism which keep the two together and keep the electrons revolving round the nucleus. So in the case of microscopic bodies like the atoms the forces of electromagnetism are operative whereas in the case of heavenly bodies it is the force of gravitation which predominates and maintains the cosmic unity.

After a hard labour extending over 22 years Einstein came to the conclusion that the forces of gravitation and electromagnetism can be represented by the same set of equations. In other words they are fundamentally the same.

could propogate it" Or in the words of Dr. N. R. Sen "How this mechanism of action at a distance operates, the theory (Newton's theory of gravitation) is silent about the point."

It is the greatest triumph of the Jain theory of Adharma Dravya that science had to postulate the existence of an invisible force of gravitation to account for the stability of the Universe, and that Einstein's modification of the law of gravitation had entirely divested the latter of its active character. Gravitation is now regarded as an auxiliary cause and not an active puller, so that its character is now brought in exact conformity with the Jain view:

"स्थितिपरिणामिनां जीव-पुद्गलानां स्थित्युपग्रहे कर्तव्ये अधर्मास्तिकाय: ।"[82]

(The principle which guarantees the permanence of world structure is called Adharma).

And further

"नित्योऽमूर्तः क्रियाहीनश्छायेव पथिकांगिनाम् ।।"[83]

i. e. Adharma, like Dharma, is without form, inactive and eternal, (it is the auxiliary cause of rest to soul and matter) as is the shade of a tree the auxiliary cause of rest for the travellers.

ĀKĀŚA

We now take up the next Dravya ākāśa According to Ācārya Umāswāmi.

आकाशस्यावगाहः ।।[84]

(The function of space is to give place to all other substances ; or interpenetrability is the characteristic of Ākāśa.) Or

जीवपुद्गलादीनामवगाहिनामवकाशदानमवगाह आकाशस्योपकारो वेदितव्यः ।[85]

(That which accommodates souls, matter, time and media

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82. *Sarvārtha Siddhi* on Sutra 5.17
83. *Vardhamāna Purāṇa*, 16.30
84. Tattvārtha Sūtra, 5.18
85. *Sarvārtha Siddhi*, on Sūtra 5.18

of motion and rest is called the Space.[86])

The author of *Dravya Saṃgraha*, Nemicandra Siddhānta-cakravarti, describes Ākāśa as follows :—

अवगासदाणजोग्गं जीवादीणं वियाण आयासं ।
जेण्हं लोगागासं अल्लोगागासमिदि दुविहं ।।[87]

(According to Jainism, that which allows space to Jīva, etc., is to be known as Ākāśa. The Ākāśa is of two kinds : Lokākāśa and Alokākāśa.)

The learned author of Tattvārthavārtika says :

आकाशन्तेऽस्मिन् द्रव्याणि स्वयं वाकाशत इत्याकाशम् ।

जीवादीनि द्रव्याणि स्वैः स्वैः पर्यायैः अव्यतिरेकेण यस्मिन्नाकाशन्ते प्रकाशन्ते तदाकाशम्, स्वयं चात्मीयपर्यायमर्यादया आकाशत इत्याकाशम् अवकाशदानाद् वा । (अथवा इतरेषां द्रव्याणामवकाशदानादाकाशमिति पृषोदरादिषु निपातितः शब्दः ।)[88]

The same author Shri Akalaṅkadeva has illustrated the accommodating power of space by saying that Ākāśa allows

86. According to the Hindu theory of Creation, Ākāśa is the primeval substance from which the other elements arose and therefore, as Dr. Thibaut has pointed out, Akāśa must mean some form of subtle matter and not the mathematician's space. For this reason Dr. Thibaut has invariably used the word 'Aether' to denote Ākāśa and according to him this is the only consistent translation. But the Jain thinkers do not believe in the theory of creation and consequently they acknowledged space to be an objective reality—not aether. In the words of Prof. A. Chakravarty (quoted from the Philosophical Introduction to Pañcāstikāya Sārā) "curiously the non-Jain Indian systems of thought do not pay any prominent attention to the problem of space. In fact the more influential Indian system of philosophy, the Vedānta uses the term Ākāśa indifferently to denote space and aether. It is the latter meaning which is more prominent. It is to the credit of ancient Jain thinkers that they took a bold attempt to attack the problem and that with very great success. This fact is perhaps due to their great interest in mathematics. An adequate solution of the problem of space and time is intimately connected with Mathematical Philosophy. It is modern mathematics that has successfully reclaimed once again space and time from the destructive dialectic of the idealistic metaphysics. Space is indispensable to Science and Realistic Metaphysics. The wonders of modern science are all associated with the reality of space and what is contained therein. Hence to the 'Indian Realism' space cannot but be real."

87. *Dravya Saṁgraha*, 19.

88. *Tattvārtha Rājavārtika* on Tattvārtha Sūtra. 5.1 (21-22)

other substances to penetrate itself just as water allows a swan (यथा हंसो जलमवगाहते[89]) but this analogy should not be interpreted too strictly. In fact a swan displaces a certain volume of water while Ākāśa being a subtle substance, the idea of displacement does not occur there.

We give below a few more quotations to show that the idea of space in Jainism refers to the mathematician's real space and not to any such thing as the æther :—

"जीवानाम् पुद्गलानां च कालस्याधर्मधर्मयोः ।
अवगाहनहेतुत्वं तदिदं प्रतिपद्यते ।।"[90]
"नित्यं व्यापकमाकाशमवगाहैकलक्षणम् ।
चराचराणि भूतानि यत्रासंबाधमासते ।।"
"लोकालोकनभोभेदादाकाशोऽत्र द्विधा भवेत् ।
अवकाशप्रदः सर्वद्रव्यानां मूर्तिवर्ज्जितः ।।"[91]

Exactly the same idea is expressed in the Svetāmbara Sūtra :

"अवगाहणालक्खणे णं आगासत्थिकाए ।"[92]

(To accommodate objects is the characteristic of space.)

The nature and the characteristics of space are very fully described in *Pañcāstikāya Sāra* of Swāmi Shri Kundkundācārya. We reproduce below the Prākṛta Gāthās with translation and part of the commentary by Professor A. Chakravarti :[93]

सव्वेसिं जीवाणं सेसाणं तह य पुग्गलाणं च ।
जं देदि विवरमखिलं तं लोए हवदि आयासं ।।[94]

What contains or accommodates completely all Jīvas and Pudgalas and the remaining Dravyas is the world space or Lokākāśa.

जीवा पुग्गलकाया धम्माधम्मा य लोगदोणण्णा ।
तत्तो अणण्णमण्णं आयासं अंतवदिरित्तं ।।[95]

89. *Rājavārtika* on *Tattvārtha Sūtra* 5.18.
90. *Tattvārtha-Sāra*, 3.38.
91. *Vardhamāna Purāṇa*, 16.31.
92. *Vyākhyā-Prajñapti*, 13.4.481.
93. *Pañcāstikāya-Sāra* (with Eng. Trans. & Eng. Commentary, edited by Prof: A. Chakravarti, S.B.J. Vol. III), p. 99-104.
94. Pañcāstikāya, gātha 97.
95. Ibid. gāthā 98.

Life, matter, the principle of motion and that of rest and also time, these are not distinct from the world. But that which is the same as the world and also distinct from it, is Ākāśa or space which is finite.

COMMENTARY

The constituent elements of the world are the infinite number of Jīvas, and the *infinite physical objects, the principles of* motion and rest and space and time. Of these space contains the other five. The space which is co-extensive with these objects is called Lokākāśa. But this is only a part of real space. Beyond the Loka there is Alokākāśa or Anantākāśa. This Anantākāśa is pure space. There are no objects animate or inanimate in this Infinite Beyond. Not a tiny molecule of matter nor a stray Jīva would step beyond the limits of Loka. The system of objects is held together by the principles of Dharma and Adharma. And these principles are confined to Lokākāśa.

Thus we have to note that mathematically pure space is recognised to be possible by Jain thinkers.

Ākāśa thus accommodates the other Dravyas. Why should it not be taken also as the condition of motion and rest? The author shows why it cannot be such a condition.

आगासं अवगासं गमणट्ठिदिकारणेहिं देदि जदि ।
उड्ढंगदिप्पधाणा सिद्धा चिट्ठंति किध तत्थ ॥[96]

(If space, in addition to accommodating other things conditions their motion and rest, then why do these Siddhas whose tendency is to go upwards come to stay at the summit of the world?)

COMMENTARY

The author evidently explains why it is necessary to postulate the existence of Dharma and Adharma. Cannot Ākāśa be credited with the function of motion and rest in addition to its own function of accommodating things? According to the author such a hypothesis would be impossible. It would be conflicting with other facts, for if it is also the condition of motion and rest, then wherever there is Ākāśa there should be free chance for

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96. Ibid. gāthā 99.

motion and rest. But neither a single Jīva nor a single atom of matter could step beyond the limit of Lokākāśa though there is Ākāśa beyond. Therefore the author concludes that space is not the condition of either motion or rest. These require independent principles as their condition. Ākāśa cannot be a substitute for Dharma and Adharma. The Jain System evidently considers the world incomplete and unreal without the statical and dynamical principles.

In Gāthā No. 100, the author has emphasised the same point again. "Since there is a definite Loka," he says, "and since there is space beyond, there must be something besides space which maintains the integrity of the system of things and persons. For space itself cannot have that function of maintaining the unit of the world."

In a Gāthā of Pañcāstikāya we have:—

जदि हवदि गमणहेदू आगासं ठाणकारणं तेसिं ।
पसजदि अलोगहाणी लोगस्स य अंतपरिवुड्ढी ।।[97]

(If space be the condition of motion and rest, of life and matter, then there would happen the disappearance of Aloka or the beyond and the destruction and dissipation of Loka or the world.)

COMMENTARY

As a matter of fact, the world is an integral system of things, living and non-living, existing in space. That there is some force or power which holds the constituent elements of the world together is a necessary pre-supposition even of modern science. It *is really wonderful that Jain thinkers several centuries ago felt the same intellectual necessity of supposing a physical force which maintains the cosmic unity.* The reason given for that hypothesis is still more interesting. If there is no such power and if things living and non-living were left in space by themselves without a further principle to hold them together, there would be only chaos, no systematic world. This argument must be considered very important for it gives us an insight into the scientific ideas of the ancients. *The positive science of*

97. Ibid. gāthā 101.

ancient Indians must have been fairly advanced in order to promulgate such physical theories as are contemplated by the author.

In next Gāthā, the same fact has again been asserted:

तम्हा धम्माधम्मा गमणट्ठिदिकारणाणि णागासं ।[98]

(Dharma and Adharma, i.e., Aether and gravitation are the condition of motion and rest respectively and not Ākāśa or space.)

In next Gāthā the author states that Lokākāśa or world-space, Dharma and Adharma, are all co-extensive and coincident. Hence they may be considered as one conventionally as they are all incorporeal entities in the same locality. But they are in reality different from one another on account of their functional difference.

धम्माधम्मागासा अपुधब्भूदा समाणपरिमाणा ।
पुधगुवलद्धिविसेसा करंति एगत्तमण्णत्तं ।।[99]

(Dharma, Adharma and space are mutually interpenetrating and coincident. Hence they are one from the point of locality; they are of the same size and form and constitute an inseparable unit. But from the difference of function they also exhibit their diversity.

COMMENTARY

This Gāthā is interesting for this reason that Dharma and Adharma being constitutive elements of the world are said to be confined to Lokākāśa. Their influence is not felt beyond the boundary of the world, for their influence is fundamentally related to things material and spiritual. These two mysterious physical principles are all-pervading and co-extensive with the world space. Their existence cannot be inferred from their difference of locality. There is no such difference. But yet they have fundamentally different functions and on account of these differences they are really diverse. In short they are in one *Predeśa* (unit of space) but different as Vastus, i.e., they have a unity of locality with diversity of function and nature.

This functional difference is emphasised by the author only

98. Ibid. gāthā 102,
99. Ibid. gāthā 103.

because they three Dravyas are Amūrta. There is no other way of differentiating them unlike physical objects which can be distinguished by sense qualities and unlike Jīvas which can be differentiated by conscious qualities. Dharma and Adharma have to be determined only by their function in the economy of the physical world.

(Quotation ends here.)

Now compare the purport of these beautiful gāthās with the proclamations of modern science. Just as the Jaina thinkers have divided space into Lokākāśa, i.e., a finite universe and an infinite void beyond, so is the verdict of the modern mathematician.

"Strangely enough the mathematicians reckon that the total amount of matter which exists is limited, and that the total extent of the universe is finite. They do not conceive that there is a limit beyond which no space exists but that the totality of space is so 'curved' that a ray of light, after travelling in a direct line for a long enough time, would come back to its starting-point. They have even made a preliminary estimate of the time a ray of light would require for the round trip in the totality of curvature—not less than ten trillion, i.e., 10000000000000000000 years. And such a space is very cosy quarters compared with infinity. A mathematician feels positively cramped in it."[100]

Again the same author writes:—

"Think of the most remote and abstract of all the theorems of Relativity—that the universe is finite. This is quite inconceivable; no astronomer can secure any mental picture of a jumping-off boundary beyond which there is no space...When a computation implies that space is 'finite' the mathematician cannot unmake his brain and visualize finite space. He does not even try to do so. But he presumes that the equation has some concrete meaning and that the meaning may in time take form and be revealed as a serviceable fact-dim, but actual on the border of the unknown."[101]

Mr. Ward may, please, note that it is not in the least necessary 'to unmake the brain and visualize finite space' if we slightly modify our present theory and accept the Jaina idea of a finite

100. *Exploring the Universe* by H. Ward. p. 16.
101. Ibid., p. 266.

universe and an infinite empty space beyond, in which exists nothing, no soul, no matter and no media necessary for motion and rest. How very reasonable and easily conceivable it is to suppose that beyond the boundary of the finite universe the medium of motion (Dharma Dravya of Jaina philosophy) is absent and thus a ray of light or any other form of energy or even a single particle of matter cannot go beyond Lokākāśa i.e. beyond the boundary of the finite universe. Thus the stability of the universe is established without postulating the idea of 'curving of space', the latter being a difficult pill to swallow.

Einstein, however, has taken up a more correct view and accordingly the great relativist Professor Eddington writes:—

"I suppose that every one has at sometime plagued his imagination with the question, Is there an end to space ? If space comes to an end, what is beyond the end ? On the other hand, the idea that there is no end, but space beyond space for ever, is inconceivable. And so the imagination is tossed to and fro in a dilemma. Prior to the relativity theory the orthodox view was that space is finite. No one can conceive infinite space; we had to be content to admit in the physical world an inconceivable conception-disquieting but not necessarily illogical. Einstein's theory now offers a way of out of the dilemma. Is space infinite or does it come to an end ? Neither. *Space is finite but it has no end*;[102] "finite but unbounded" is the usual phrase."[103]

The same view was expressed by Professor A. C. Banerji, M.A. (Cantab.), M.Sc. F.R.A.S., I.E.S., (Professor of Mathematics, Allahabad University) in a lecture on '*The Expanding Universe*'[104] Says he :

"According to Einstein's original theory of Relativity, dimensions of space are determined by the amount of matter it contains. Space, if there be matter inside, bends round until it closes up. The more matter there is, the smaller space there must be and 'space could only be of literally infinite extent if

102. This is very approximate to the Jaina view of Lokākāśa and Alokākāśa.

103. *The Nature of the Physical World*, p. 80.

104. This lecture was delivered at the *Science Congress*, Bombay, 1933.

it contained no matter at all.'[105] So matter is responsible for the curvature of space dimensions. So in Einstein's space containing matter, if one goes right on in one direction one does not get to infinity but gets back to his starting-point again. 'Closed space differs from an open infinite in the same way that the surface of a sphere differs from the infinite plane'. We say that the surface of a sphere is (1) a curved surface and (2) a closed surface enclosing a three-dimensional volume. Similarly we can say that our three-dimensional space is (1) a curved space and (2) a closed space, enclosing a four-dimensional[106] continuum. *In Einsein's world the time dimension is uncurved and so may extend to infinity.* It is what is called Einstein's cylindrical world."

The last words which we have italicised are worthy of notice. In plain simple words they mean that the universe extends in the direction of time from an infinite past to an infinite future. To be more explicit, *there was never a beginning of the universe nor will it ever come to an end.* This fact is the fundamental substratum of Jaina philosophy. It regards the universe with its contents as eternal and uncreated:—

जीवा पुग्गलकाया धम्माधम्मा तहेव आयासं ।
अत्थित्तम्हि य णियदा अणण्णमइया अणुमहंता ॥[107]

(Souls, matter, the media of rest and motion and finally space, these are the entities which are eternal, uncreated and of immense magnitudes.)

What greater confirmation we require for the truths enunciated by the Jaina Ācāryas? The Cylinder Theory of the Universe is explained in more clear terms by Professor N. R. Sen, D.Sc. (the famous worker on the theory of relativity). He quotes the following view of Professor Einstein:—

105. Mark the very interesting, at the same time, strange argument against the non-infinity of space.

106. Einstein's theory regards the universe as a four-dimensional space-time continuum, the three directions of space being combined with the fourth dimension of time. A brick with its length, breadth and thickness must grow in the direction of time in order to be a brick. A brick existing for no time is absurd.

107. Pañcāstikāya, gāthā 4.

"Einstein himself asserts that the universe consisting of large and small masses hanging apparently in infinite space is not in fact infinite. One suggestion from his theory is that the universe of four dimensions is finite in spatial directions and infinite in the direction of time. It is like a cylinder whose surface is bounded in some direction, viz., across the lines which generate the cylinder. This finite dimension corresponds to the three spacial dimensions of our world of perception. But the cylinder is also infinite in two other directions, *so is also our universe which is infinite in the dimension of time running from the infinite past into the infinite future*"[108].

There can be no clearer pronouncement than this about the finiteness of the Loka, i.e., universe and its eternity, thus establishing the Jaina viewpoint beyond the shadow of a doubt. It should be noted, however, that while Jaina philosophy regards only a part of Loka as finite and an infinite space beyond, the Einsteinian view regards the whole Loka as finite with nothing beyond it. For, says Eddington "In any case the physicist does not conceive of space as void"[109]. Let us hope that this little difference will disappear as science advances for, as again in the words of Eddington, as "it is inconceivable that there was once a moment with no moment preceding it,"[110] so it is inconceivable that there should be no space beyond a certain space.

PUDGALA

The last substance mentioned in the Sūtra is Pudgala which falls within the category of non-living substances. On page 1 we have translated this word as 'matter and energy' and it is exactly in this sense that the term has been used by the Jain writers. At this stage we shall discuss only one phase of Pudgala Dravya. The word Pudgala has the following derivation :—

108. Vide Dr. Sen's article on 'Relativity' published in the *Proceedings of the Physics Seminar*, Allahabad University, July 1925.

109. *The Nature of The Physical World*, p. 137.

110. Ibid.

"पूरयन्ति गलयन्ति इति पुद्गलाः"[111]

(Pud (पुद्) means 'to combine' and gala (गल) means to dissociate.)

Hence the root-meaning of the word Pudgala is: "that which undergoes modifications by combinations and dissociations." This definition of Pudgala is so full of significance and deep meaning that those who are conversant with the developments in modern atomic physics can fully admire and appreciate the use of the word 'Pudgala' to denote matter. We shall describe in brief how one form of matter is changed into another form by the combinations and dissociations of elementary constituents of matter, viz., electrons and neutrons. The nature of the electrons has already been explained in this book (on page 10). What neutrons are we shall explain in the following pages.

"In the last century the childish musings of the alchemists[112] were regarded as things definitely of the past; science had no more use for them; it had triumphed—so it was thought—in establishing that elements were unchangeable and indivisible. In the present century, however, the problem which the alchemists set themselves has again been revised, though in quite a different form. It will presently be seen that this very miracle of alchemy has been performed in the Cavendish Laboratory under Lord Rutherford's direction. In the phenomenon of radio-activity elements are seen transforming themselves of their own accord into others"[113].

As explained in Figure 3 on page 12, all atoms are an assem-

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111. (a) पूरणगलनान्वर्थसंज्ञत्वात्पुद्गलाः ।

(Rāja-Vārtika on Tattvārtha Sūtra, 5·1)

(b) वर्णगन्धरसस्पर्शैः पूरणं गलनं च यत् ।
कुर्वन्ति स्कन्धवत्तस्मात् पुद्गलाः परमाणवः ॥

(Harivaṁśa-Purāṇa, 7·36)

(c) पूरणात् पुद् गलयति गल इति पुद्गलः ।

(Śabdakalpadruma Kośa)

(d) छव्विहसंठाणं बहुविहदेहेहिं पूरदि गलदित्ति पोग्गलो ।

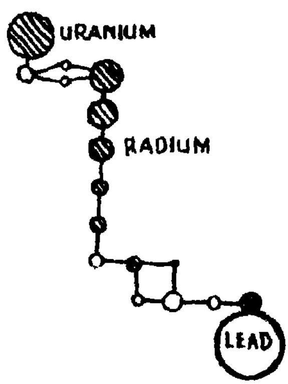
(Dhavalā)

112. Alchemists were those ancient workers in chemistry who posed to have discovered the methods of converting copper or mercury into gold.

113. Vide *The World in Modern Science* by Infeld.

blage of electrons, protons and neutrons in different numbers. Uranium, a metal element, is radio-active. Radio-activity has nothing to do with radio broadcasting. It is a technical term which expresses a peculiar property of certain metals. Uranium emits, day and night, unceasingly three kinds of rays which are denoted by Greek names, *alpha*, *beta* and *gamma*. Alpha rays are streams of particles which are the nucleii of Helium atoms. Beta rays are streams of electrons; and gamma rays are the rays of the nature of light. When an atom of uranium loses three alpha particles it is converted into an atom of radium.[114] The atom of radium is again radio-active, i.e., it emits day and night the same three kinds of rays. When one atom of radium loses five alpha particles it is converted into the metallic lead.

This is a confirmation of one part of the definition of Pudgala. This shows the dissociative (गलयन्ति) character of Pudgala Dravya, one form of matter changing into another form by the separation of electrons and protons. In the adjoining figure is given the full chain of radio-active changes in uranium.



(The chain shows the formation of different substances by the separation (गलयन्ति) of alpha and beta particles from within the atoms. The circles of different sizes show the relative weights of the different substances formed.)

Fig. 4

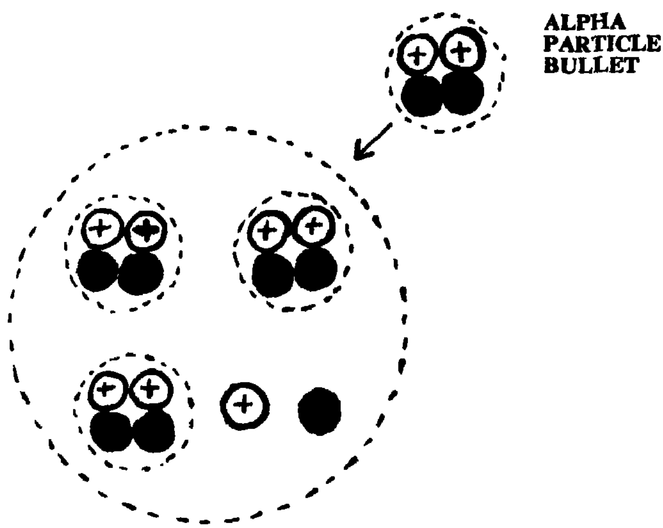
In confirmation of the above series of changes in uranium metal it may be mentioned that there exist, in the earth's crust, rocks which are rich in uranium. Radio-active disintegration, i.e., the breaking up of atoms by the emission of alpha and beta rays, is unceasingly proceeding in these rocks. Geological researches have shown that the end-product viz. lead metal is always found

114. Radium is the costliest metal on earth, the present price being about Rs. 3,00,000 per tola. It is being successfully used in the treatment of cancer of the heart and other deadly diseases of the skin. Recently it has been replaced by cobalt 60.

embedded in these rocks together with uranium in a fixed proportion. It is in fact with the help of the uranium-lead ratio that the age of these rocks is estimated, thus establishing beyond doubt that lead is formed by the gradual disintegration of uranium.

We shall now give an account of the work which has been done in the Cavendish Laboratory of England in order to produce one kind of atom from another kind artificially.

Figure 5 shows the nucleus (central core) of an atom of nitrogen gas and at the right-hand top corner of the same is shown an alpha particle which has been used as a bullet in the experiment.



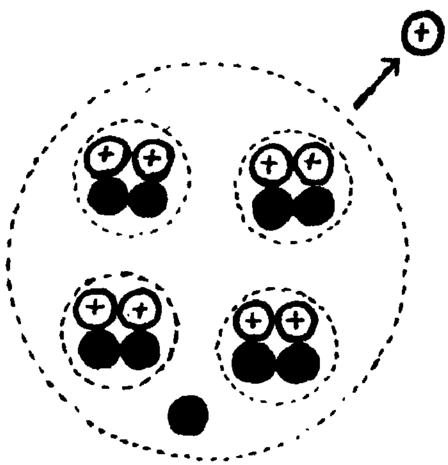
Nucleus of Nitrogen atom before bombardment.

The bigger circle represents the central core (nucleus) of the nitrogen atom. It consists of three alpha particles, one proton and one neutron. The three alpha particles are shown by three smaller circles within the big circle. The symbol (+) represents a proton and the black disc, a neutron. Each alpha particle again consists of two protons and two neutrons.

Fig. 5

The above figure shows that an alpha particle bullet from an outside source is just on the point of being short into the

interior of the nucleus. What happens after the bombardment is shown in Figure 6 below.



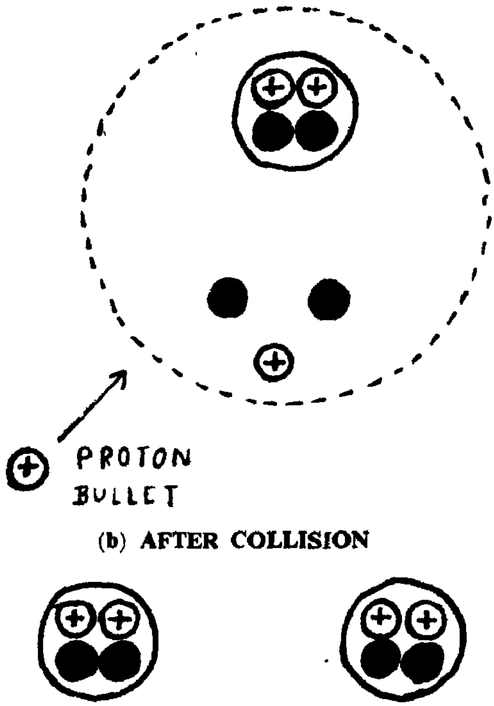
Nucleus of Oxygen atom formed by bombardment.

Fig. 6

In the words of Prof. Infeld "The catastrophe produced by a collision between the nucleus of the atom and the bombarding alpha particle expels a proton from the nucleus of the nitrogen atom. One asks, therefore, what further happens to the bullet which has caused the catastrophe ? What becomes of the alpha particle after the collision ? To this question, too, experiment gave its answer a few years ago. *The bullet remains embedded in the nucleus at which it was projected.*" There can be no better example of the combinational (पूरयन्ति) character of Pudgala Dravya. The comparison of Figures 5 and 6 clearly shows how the foreign alpha particle has filled an empty place and produced an atom of oxygen from an atom of nitrogen. Thus the definition of Pudgala viz., पूरयन्ति, गलयन्ति इति पुद्गलाः establishes itself fully. However we shall give two more illustrated examples before closing the subject.

Fig. 7 (*see* next page) shows the bombardment of the nucleus of lithium atom with a proton bullet. The figure clearly shows that if a proton is added to the nucleus, another alpha particle will be completed, for there are one proton and two neutrons in the free state, and the addition of one more proton will make two

(a) BEFORE COLLISION



Above :—Lithium Nucleus before collision.
Below :—Lithium Nucleus after collision.
Fig. 7

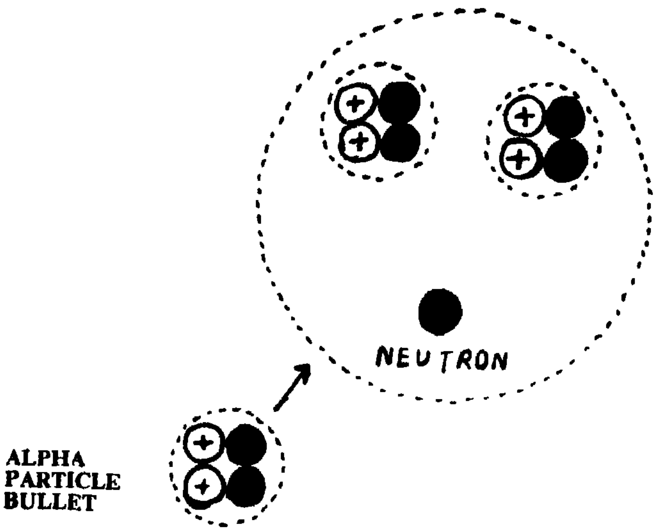
protons and two neutrons ; that means an alpha particle. This is another example of पूरयन्ति, i.e., filling a gap. At the same time the lower figure shows that the nucleus bursts and the two alpha particles fly in opposite directions, i.e,, गलयन्ति. It shows that in this case the processes of combination (पूरयन्ति) and dissociation (गलयन्ति) proceed side by side resulting in the transformation of a lithium atom into two alpha particles.

The case of beryllium metal is interesting. As Fig. 8 (*See next page*) shows there are two alpha particles and one neutron inside its nucleus.

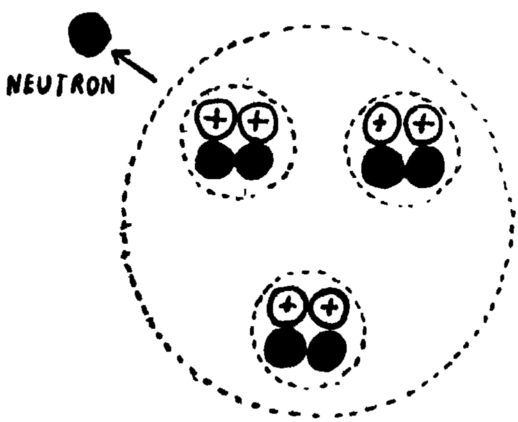
The lower circle of Fig. 8 shows how the bullet gets embedded in the nucleus and the neutron is shot out. This is again a case of combination and partial dissociation. The resulting

atom is an atom of carbon, i.e., beryllium is converted into carbon by the alpha particle bullet.

(a) BEFORE COLLISION



(b) AFTER COLLISION



Above :—Beryllium nucleus before collision.
Below :—Beryllium nucleus after collision.

Fig. 8

Experiments have been performed with many[115] more metals but these examples will suffice. It should be noted that in all these experiments alpha particles or proton bullets of very high energy were produced by technical methods and then shot into the atoms so that the bullets may penetrate the interior of the nucleus and produce the transformations recorded.

This discussion leaves no doubt that the selection of the word Pudgala for matter is full of very deep meaning and must have been selected after a profound thinking. It is worthy of note that the use of this word is quite peculiar to Jainism ; it does not even exist in the lexicons edited by non-Jaina writers.

A NOTE ON 'PUDGALA'

In the last few years an intensive hunt has been going on all over the world for the search of the 'Ultimate Particle' of matter (the Pudgala) called the Quark by the scientist.[116] The hunters are some of the world's leading physicists. The hunting grounds : almost anywhere from the high atmosphere to the bottom of the sea to the inside of the latest atom smasher.

Despite this painstaking search, it has not been possible so far to track down the Quark. According to modern theoretical physicists, the quark is the simplest particle in the universe out of which every thing is made. The two most prominent workers in this field are Murray Gell Mann and Richard Feynman of California Institute of Technology and their collaborators. Gell Mann and Feynman both have won high honours. In 1965, Feynman shared the Nobel prize for his achievements.

From the very start of civilization philosophers have wanted to find a simple idea that would unite every thing we experience in the world around us. So there has always been a search for the building block, like the cell or gene in biology.

The burning questions before the theoretical physicists of today are : (1) what are things really made of ? (2) Have we at

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115. The discovery of artificial radio-activity made by Irene Curie and F. Joliot in 1934 has given us many more transformations such as conversion of aluminium into phosphorus, phosphorus into silicon, magnesium into silicon, silicon into aluminium, sodium into radio-sodium, radio-sodium into magnesium, sulphur into phosphorus, and many more all brought about by alpha particle, proton or neutron bombardments.

116. *American Review*, April, 1969, page 78.

last come down to the last foundation stone from which we can build any thing : a table, a human being, or a universe ? OR (3) must we go on looking at smaller and smaller pieces, and going deeper and deeper into a bottomless pit ?

To answer these questions very elaborate and expensive experiments were performed in America as a result of which the number of new particles emerging from nucleus has increased fantastically. By 1962 their number had been counted up to about 100. Some of their names are neutrons, protons, pions, positive electrons, negative electrons, muons, neutrinos and their anti-particles such as anti-protons and so on. Millions of photographs were taken and even those particles were recorded who lived for as small a period as one ten-billionth of a second (एक सैकिंड का दस अरबवां भाग) and then died but the quark remained undiscovered.[117]

We congratulate the scientists on their hard perseverance and unceasing labour.

●

SŪTRA 2.

द्रव्याणि ॥२॥

DRAVYĀṆI (2)

According to Śvetāmbaras, this Sūtra has been combined with the following Sūtra and we have :

द्रव्याणि जीवाश्च

(*dravyāṇi Jīvāśca*).

which means that Dharma, Adharma, Ākāśa, Pudgala and all Jīvas, these are the five Dravyas and ***not time***.

According to Digambaras, the Sūtra means :

धर्म-अधर्म-आकाश-पुद्गला: द्रव्याणि ॥

i.e., Dharma, Adharma, Ākāśa, and Pudgala are the Dravyas.

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117. Experiments performed in high energy Physics at Standford Laboratory U.S.A. have proved that three quarks make up the proton and the neutron (S.R., Dec., 1971).

Then in Sūtras 3 and 39 we have :

जीवाश्च ॥३॥

Jīvāśca (3)

कालश्च ॥३९॥

Kālaśca (39)

i.e., Jīvas and Time are also Dravyas.

Thus according to the Digambara version there are six Dravyas or Realities : Jīva, Pudgala, Dharma, Adharma, Ākāśa and Kāla.

Dravya has been defined as

"पर्यायैः द्रूयन्ते द्रवन्ति वा तानि इति द्रव्याणि" [118]

(That which undergoes modifications is a Dravya).

To give one example of such modifications, consider an ingot of gold. Suppose we make an ornament out of it. The original mass of gold suffers a modification, the fundamental form is destroyed (Vyaya), a new form is produced (Utpāda) but the substance gold persists (Dhrouvya) throughout the change. Hence the following Sutras—

उत्पादव्ययध्रौव्ययुक्तं सत् ॥

सद् द्रव्यलक्षणम् ॥

(Tattvārtha Sūtra 5.30 & 5.29)

(i.e., every substance in the universe possesses the quality of permanency (dhrouvya) with generation (Utpāda) and decay (Vyaya) as modifications of itself. It is technically called *sat* and *sat* defines a substance or a Dravya).

In Tattvārtha Rājavārtika (5.29) we read

"स्वजात्यपरित्यागेन भावान्तरावाप्तिरुत्पादः। तथा पूर्वभावविगमो व्ययनं व्ययः। ध्रुवे स्थैर्यकर्म्मणो ध्रुवतीति ध्रुवः।"

(Utpāda is the modification of a substance without leaving its own kind; Vyaya is the disappearance of a form and Dhrouvya consists of the persistence of the fundamental characteristics throughout various modifications.)

Professor A. Chakravarti has summarised in a beautiful way the characteristics of a Dravya. "The term Dravya denotes

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118. *Sarvārtha Siddhi* on Tattvārtha Sūtra 5.2.

any existence which has the important characteristic of persistence through change. Jaina conception of reality excludes both a permanent and unchanging real of the Permenidion type and also the mere eternal flux of Haraclites. An unchanging permanent and mere change without substratum are unreal and impossible abstractions. Jaina system admits only the dynamic reality or Dravya. Dravya, then, is that which has a permanent substantiality which manifests through change of appearing and disappearing. Utpāda—origin, Vyaya—decay and Dhrouvya—permanency form the triple nature of the Real. To emphasize the underlying identity also would end Vedāntic conception of this Real as Brahman. To emphasize the change alone would result in the Kśaṇika Vāda of the Buddhist. The reality is a stream of discrete and momentary elements. The concept of Dravya reconciles both these aspects and combines them into an organic unity. It is an identity expressing through difference, a permanency continuing through change. It corresponds to the modern conception of organic development rather in its Hegelian aspect. It has duration; it is movement; it is the Elan Vital. The five Astikāyas and Kāla or time are the six Dravyas or real existence."[119]

The Jaina view of Dravya expressed in the summary quoted above is based on the following gāthās of Pañcāstikāya Sāra.

ते चेव अत्थिकाया तेक्कालियभावपरिणदा णिच्चा ।
गच्छंति दवियभावं परियट्टणलिंगसंजुत्ता ॥[120]

(These five Astikāyas, though manifesting themselves in multifarious forms, maintain their permanency and together with time, they constitute the six Dravyas, since time also possesses the characteristic of persistence through change and is therefore a Dravya.)

दव्वं सल्लक्खणियं उप्पादव्वयधुवत्तसंजुत्तं ।
गुणपज्जयासयं वा जं तं भण्णंति सव्वण्हू ॥[121]

(The All-knowing Tirthankaras have said that whatever has substantiality, undergoes birth and death through persistence

119. Philosophical Introduction, *Pañcāstikāya Sāra*, edited by Prof. A. Chakravarti, p. XXIX.

120. *Pañcāstikāya-Sāra*, gāthā 6.

121. Ibid., gāthā 10.

and is the substratum of qualities and modifications is called the Dravya.)

Three points have been stressed in this gāthā. Dravya is 'Sat', substantiality or existence: it has the quality of permanence through birth and death and lastly it is the basis in which attributes rest and modifications take place. It should be noted, however, that birth does not mean 'coming into being out of nothing'; it means the production or development of a new form. Death does not mean the complete annihilation of the substance but simply the death of the previous form. This dialectical triad of birth, death and permanence 'is not only recognized by the scientists like Dārwin and Spencer but by the great French philosopher, Bergson, who raised it to an important philosophical principle'.[122]

Lastly the qualities or attributes in order to be real must have an objective basis and such a basis is a Dravya.

Now we give below the evidence of present-day science on the subject of permanence of substances through birth and death. The sphere of 'Science' is the Pudgala Dravya (i.e., matter and energy) only since soul and other Amūrta Dravyas are not amenable to measurement and Science means 'measurement'. Consequently laws have been investigated and formulated concerning matter and energy only. *The principle of conservation of matter* and the *principle of conservation of energy* are the two fundamental laws of physics.

"This theorem (the law of conservation or persistence of energy) is usually considered to be the flower of the mechanical world,—the highest and most general theorem of natural science, to which the thought of many centuries has led."[123]

Referring to this doctrine Prof. A. N. Whitehead, D.Sc., F.R.S., writes "The doctrine of energy has to do with the notion of quantitative permanence underlying change."[124]

Mark the coincidence of the words 'permanence underlying change', the words which we have oft used in the translation of the previous gāthās. It means nothing but Utpāda, Vyaya, Dhrouvya.

Writing under the heading "Energy, like matter, is indestruc-

122. Vide. Commentary by Prof. A. Chakravarti on *Pañcāstikāya Sāra*, gāthā, 10.

123. *Inorganic & Theoretical Chemistry*, by J. W. Mellor, Vol. I, p. 269.

124. *Science and The Modern World*, p. 126.

tible" Dr. J. W. Mellor writes "Whenever it has been possible to make accurate measurements, it has been found that when any quantity of one form of energy is made to *disappear*, an equivalent quantity of another form, or forms of energy *appears*."[125]

L. A. Colding said :

"Energy is imperishable and immortal and therefore, wherever and whenever energy seems to vanish in performing certain mechanical or other work, it merely *undergoes transformation and re-appears in a new form but the total quantity of energy still abides*."[126] The italicized words again mean the Utpāda, Vyaya, Dhrouvya in the Pudgala Dravya.

In the brilliant writings of the French physicist Sadi Carnot (died 1832) the following words occur:—

"True enough, (energy) may change its form or produce sometimes one kind of motion and sometimes another, but it is never annihilated." It means permanence through change.

What has been said about energy is equally true about matter. A few years after Lord Mahāvīra, Democritus, the great Greek philosopher also taught—*ex nihilo nihil fit, et in nihilum nihil potest reverti*—nothing can ever become something, nor can something become nothing.

In the nineteenth Century Herbet Spencer announced that "the annihilation of matter is unthinkable for the same reason that the creation of matter is unthinkable, the reason, namely, that nothing cannot be an object of thought."

The latest work of the great chemist Dr. J. W. Mellor contains the following statements :

"In all changes of a corporeal nature, the total quantity of matter remains the same, being neither created nor destroyed (Anādinidhana). Superficial observation might lead to the belief that a growing tree, the evaporation of water, and the burning of a candle prove the creation and destruction of matter but a careful study of these and innumerable other phenomenæ, has shown that the apparent destruction of matter is an illusion...The law of persistence of weight or the so-called law of indestructibility of matter means that...substance persists while matter changes its form."[127]

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125. *Inorganic & Theoretical Chemistry*, by J. W. Mellor, Vol. I, p. 691.
126. *Thesis on Energy*, by L. A. Colding, Copenhagen, 1843.
127. *Inorganic & Theoretical Chemistry*, Vol. I, p. 101-2.

Hence, Utpāda, Vyaya, Dhrouvya as characteristics of a substance is established on modern evidence.

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SŪTRA 3.

जीवाश्च ॥३॥

JIVĀŚCA (3)

(Souls are also included in the category of substances.)

As pointed out on pages 50-51 the Śvetāmbaras and Digambaras both agree in regarding soul as a substance. One more evidence from a Śvetāmbara Sūtra is given below:

"कइविहाणं भंते ! दव्वा पण्णत्ता ? गोयमा ! दुविहा पण्णत्ता, ... तंजहा—जीवदव्वा य अजीवदव्वा य।"[128]

The existence of soul can be proved on various grounds. The faculty of knowing and perceiving, the sensations of pleasure and pain cannot inhere in nothing, nor can volition be the function of pure non-entity. All these must be regarded as states of something which exists and it is this 'something' which we call 'soul substance'. Physical researches of eminent scientists, like Sir Oliver Lodge, have proved the existence of souls. It should be noted, however, that the investigations of Experimental Science say nothing, either this way or that way, about the existence of soul, the reason being that non-material substances cannot be subjected to experiment and hence do not come within its province.

In *Exploring the Universe* the following words occur :—

"Science is now, and must increasingly become, a limited field of endeavour. Its materials are only those forces which can be measured and predicted with precision by all experiments alike. If there exists in man a free will, a conscience, a power of self-sacrifice, a social mind or a consciousness of kind, *these forces are beyond the pale of science*....The science of tomorrow, therefore, cannot include any such forces as we commonly conceive at present when we use the words, mind or soul or will or purpose."[129]

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128. *Anuyogadvāra Sūtra*, 441.

129. *Exploring The Universe* by Henshaw Ward, p. 230.

To ask Science to give its verdict with regard to the existence of soul is to ask an engineer to perform an operation on the injured part of your body. Don't think that the engineer is silly if he refuses to attend to you. It is not his province. But even the scientists, as logical thinkers, have felt that over the body and the intellect there rules a heaven-sent soul and regarding it as some form of energy they have made attempts from time to time to investigate its nature.

An account of a recent investigation carried out by a prominent South African doctor and an engineer in London was published under the caption "*Scientist Seeks the Soul.*" We reproduce below certain portions of that article :[130]

"The doctor and the engineer both thought that the secret of life lay in some kind of energy, probably electrical....Intricate apparatus was designed and built by the engineer and the experiments started. Animals were used at first. Their apparatus proved that every animal was born with a definite electric charge. They were able to record and tabulate this energy. They found that the more intelligent animals had a higher charge than the lower forms. At the moment of death the charge disappeared. In the animal experiments the records showed that the charge remained more or less the same throughout life except when the animal was breeding".

In the case of human beings they found the same laws holding and we read : "The babies were born with a definite charge. After death the charge vanished. An average human charge, they found, was 500 volts. As the subject grew older the charge increased not with age, but according to the type of character the subject was developing. The two men began to think that they were on the track not only of life but of the soul, so long sneered at by scientists. In coarse animal natures the charge remains low and in cases of mental disease and lunacy the charge dropped. They found that male babies had a higher charge at birth than female babies, but that the female could catch up and pass the male according to the various characteristics shown."

Now they are trying to find out where does the electrical charge go at death. They think that as energy it cannot dis-

130. This article was published in the 'Jayaji Pratap' of Gwalior in the issue dated 17th June 1937.

appear but must go on existing in some form. It is, therefore, reported that "the engineer is planning a new recording machine. This will not take the reading definitely from the body of the subject but from the atmosphere around it. It is based on a theory that there is an aura around every human being.

With this new machine they hope that they will be able to take the reading of the atmosphere in a room or in a building such as a hospital.

They hope that when death occurs the needle of the recording machine will not drop but will remain steady, proving that the charge is still there, in the æther filling the room.

The theory they hold now is that when a patient dies the energy leaves the body, but hovers, for a time, in the atmosphere surrounding the body."

The reading of the above account at once conveys the idea that this is not a step which will lead to the discovery of soul, since soul is a non-material, non-tangible body. But it is a brilliant confirmation of the Jaina view of Taijas-śarīra or electrical body which is closely associated with the soul. Compare the above with the following account of the Taijas-śarīra given in Jaina Śāstras :—

"The Taijasa is composed of electric or magnetic matter and is a necessary link between the outer-most body and the Kārmaṇa Śarīra (the latter being the compound arising from the union of spirit and matter)."[131]

"The Taijasa Śarīra is a coat of luminous matter thrown over the Kārmaṇa śarīra and forms an atmosphere or aura of light round it."[132]

"Taken together, the Taijasa and the Kārmaṇa Śarīras form only one organism, and accompany the soul throughout its evolution as a migrating ego."[133]

"Death signifies the departure of the soul with its two inner bodies, the Kārmaṇa and the Taijasa, from the body of gross matter."[134]

The comparison is striking and needs no comment. The scientists have after all discovered one physical counterpart of

131. *Key of Knowledge* by C. R. Jain, p. 822.
132. Ibid. p. 825.
133. Ibid.
134. Ibid. p. 834.

the soul and hence we are quite justified in regarding the soul as a separate non-material substance.

Within the last few decades the scientists are convinced that it is possible to explain all processes of life in terms of the laws of physics and chemistry. According to them the two most essential requisites of life are growth and reproduction. As a result of growth, the body exhibits locomotion and in higher animals, mental activity. All living beings contain two or three classes of chemical substances, whose special properties enable living systems to exhibit the behaviour which we characterise as life. These substances belong to the category of high polymers whose molecules contain thousands of atoms and sometimes millions of them, arranged in repeated patterns. The protein which is one of the main constituents of all living matter belongs to this group. There are twenty protein units. They do specified jobs and produce required results. For instance, a protein called the hæmoglobin (the chief constituent of blood) contains some iron atoms and serves the purpose of absorbing the oxygen from the air we breathe in and taking it to the various places in the body where the oxygen is required for maintaining the living process. There are thousands of different proteins inside any living organism and there is some sort of guiding force which exists in the cells of its tissues, which makes these proteins as required for doing their specialised duties. The guiding force is supplied by the two nucleic acids found inside the nucleius of the cells technically known as DNA and RNA.

In unicellular organisms such as the amœba. The single cell at appropriate time when it is big enough it automatically divides into two similar parts and each part is a complete amœba. On the other hand, in higher animals which also start from a single cell the cells which divide do not go apart, but stick together to give shape and form to the living being. So, what appears as growth in this case is really produced by the reproduction of the cells. The DNA produces the required proteins and duplicates itself.

In the field of artificial production of life the successful synthesis of a living cell was reported long ago and in 1968 the 'American Reporter' announced the synthesis of biologically active living cell. A biologically active cell is that which grows by automatic multiplication. At present the great Indian Chemist Mr. Khurāṇā is trying to manufacture a *gene*.

Hundreds of experiments were performed in America and elsewhere to correlate memory with proteins on the one hand, and with DNA on the other but no definite conclusion was arrived at.[135]

So far no scheme has been proposed which could explain the relation of proteins and the DNA with thought, reason, logic, intuition, decision and free-will. In other words, consciousness could not be explained on the basis of physics and chemistry and hence the existence of soul remains unchallenged.

The subject of existence of soul and its transmigration has widely been studied by scientists, and para-psychologists in India and abroad. An American scientist, Stevenson has systematically studied this problem and published valuable literature on it. Recently the Editor of the 'Daily Express', London has published about one thousand verified authentic cases of persons who have given an account of their previous lives.[136]

This leaves no doubt as to the soul being a separate substance as postulated by Jaina thinkers.

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SŪTRA 4.

नित्यावस्थितान्यरूपाणि ॥४॥

NITYĀVASTHITĀNYARŪPĀṆI (4)

(धर्मादीनि, कालः, जीवाश्च, द्रव्याणि नित्यावस्थितान्यरूपाणि)[137]

(The six substances Jīva, Ajīva, Dharma, Adharma, Ākāśa and Kāla are permanent in their nature, fixed in number as the sole constituents of the universe and (with the exception of Pudgala Dravya) are all without form, i.e., they are devoid of the characteristics of matter, viz., touch, taste, smell and colour).

The great Ācārya Shri Kundakunda Swāmi has expressed

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135. *Annual Review of Biochemistry*, 1969.

136. Read *Dharmayuga*, 25th Nov. 1973.

137. Dharma, Adharma, Ākāśa and Pudgala are embodied in Sūtra 1; Kāla or Time in Sūtra 39; Jīva in Sūtra 3; and the term Dravyāṇi is taken from Sūtra 2.

the same view in the following gāthās of Pañcāstikāya Sāra:

जीवा पुग्गलकाया आयासं अत्थिकाइया सेसा।
अमया अत्थित्तमया कारणभूदा हि लोगस्स ॥
जेसिं अत्थिसहाओ गुणेहिं सह पज्जएहिं विविहेहिं।
जे होंति अत्थिकाया णिप्पण्णं जेहिं तेल्लोक्कं ॥
अण्णोण्णं पविसंता दिंता ओगासमण्णमण्णस्स।
मेलंता वि य णिच्चं सगं सभावं ण विजहंति ॥[138]

(Tr.—The souls, the material bodies, the space, and the remaining two, viz., Dharma and Adharma are the eternal existences which constitute the universe. They are called Astikāyas.

Astikāyas are those which manifest themselves in various forms through their numerous qualities and modifications. They fill all the three worlds, i.e., they are the constituent parts of the universe.

The five Astikāyas though manifesting themselves in various forms, maintain their permanent character and together with Time constitute the six Dravyas.)

In Śvetāmbara *Nandī Sūtra*, the same idea is very clearly expressed as :—

"पंचत्थिकाए न कयाइ नासी, न कयाइ नत्थि, न कयाइ न भविस्सइ, भुविं च, भवइ य, भविस्सइ य, धुवे नियए सासए अक्खए अव्वए, अवट्ठिए, निच्चे अरूवी।"[139]

The great commentator Shri Pūjyapāda Ācārya comments on this Sūtra as follows :—

"नित्यं ध्रुवमित्यर्थः। धर्मादीनि द्रव्याणि गतिहेतुत्वादिविशेषलक्षणद्रव्यार्थादेशादस्तित्वादिसामान्यलक्षणद्रव्यार्थादेशाच्च कदाचिदपि न व्ययन्तीति नित्यानि। इयत्ताऽव्यभिचारादवस्थितानि। धर्मादीनि षडपि द्रव्याणि कदाचिदपि षडिति इयत्त्वं नातिवर्तन्ते। न विद्यते रूपमेषामित्यरूपाणि, रूपप्रतिषेधेन तत्सहचारिणां रसादीनामपि प्रतिषेधः।"[140]

(These Dravyas are eternal and unchanging in their charac-

138. *Pañcāstikāya-Sāra*, gāthā 22 & 5-6.

139. *Nandī Sūtra*, 126.

140. *Sarvārtha Siddhi* on Tattvārtha Sūtra 5.4.

teristics; the medium of motion cannot become the medium of rest or the living cannot become the non-living. The number of Dravyas is fixed as six; it can never be seven or five. (Leaving aside Pudgala Dravya) the others are non-material and formless and hence devoid of all characteristics of matter such as touch, taste, smell and colour.)

Let us now see what other Indian systems of philosophy have to say with regard to the number of Dravyas in the Universe.

In *Tarka Saṁgraha*, Sūtra 2, the following nine Dravyas as the constituent elements of the universe are enumerated :—

"तत्र द्रव्याणि पृथिव्यप्तेजोवाय्वाकाशकालदिगात्ममनांसि नवैव ।"

i.e., earth (पृथ्वी), water (जल), fire (तेज), air (वायु), space (आकाश), time (काल), direction (दिशा), soul (आत्मा) and mind (मन) these are the nine substances of the Vaiśeṣika or Kaṇāda School.

Even a casual glance will show that earth, water fire and air are included in the Jaina category of Pudgala Dravya, for the latter has been defined as

"स्पर्शरसगन्धवर्णवन्तः पुद्गलाः"

(*Tattvārtha Sūtra* 5.23)

(Material substances are possessed of touch, taste, smell and colour or form).[141]

Kaṇāda School regards air (Vāyu) as without form or colour (Vide *Tarka Saṁgraha* 1-19) but even an elementary student of physics will tell you that scientists have converted air into a bluish liquid by continuous cooling just as steam can be converted into water. This is a concrete proof that air has form or colour and is therefore included in the term 'matter'.

This school regards fire[142] as devoid of taste and smell and

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141. It should be noted that of these four characteristics of Pudgala Dravya where one exists all exist although in a particular modification of it all of them may or may not be simultaneously detectable by our physical senses. As science is gradually advancing more and more sensitive instruments are being designed and some new property added to the list of properties of various substances. The chief point is that the detection of even one of these four characteristics in any element throws it in the category of Pudgala. None of these characteristics is associated with the other Dravyas of the universe.

142. "स्पर्श उष्णस्तेजसस्तु स्याद्रूपं शुक्लभास्वरम् ।" (*Muktāvalī*)

possessing only touch and colour, while air[143] has only the characteristic of touch (see *Tarka Saṃgraha*, 1.20, 39)

The nature of air we have already pointed out. It must possess both taste and smell. And what is after all fire too. The scientists have clearly demonstrated that fire is a material substance. When the energy of molecular agitation in a substance becomes very great, its temperature rises and we get the sensation of fire. It is a form of energy and energy and matter are identical. Hence the characteristics of matter are associated with fire, for fire is composed of material particles raised to incandescence.[144] Hence fire comes within the fold of Pudgala Dravya.

They regard smell as existent only in earth (Pṛthivī). It is true that water, fire or air cannot be perceived by the nose but odour is associated with all these three forms of matter. Human nose is not sensitive enough to detect the smell of these. Several cases are known where our olefactory organ fails; for instance, a cat at once smells of milk or a hound smells of the chase.

Some modern writers have interpreted earth (Pṛthvī), water (Jala) and air (Vāyu) as connoting the solid, liquid and the gaseous states of matter respectively. If so, they automatically come within the category of Pudgala. Diśā, i.e., the directions are included in the Jaina conception of Ākāśa which is interpreted as mathematically pure space allowing accommodation to the other five Dravyas of the universe; whereas the Vaiśeṣikas have interpreted Ākāśa as a fanciful stuff something like æther from which sound originates. We shall prove in the following pages that this is an entirely a wrong notion. Coming to the last Dravya Mind (Mana) which has been regarded as the cause of succession in sensation and thought, we find it in Sūtra 18 of

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143. "अपाकजोऽनुष्णाशीतः स्पर्शस्तु पवने मतः"

(Muktāvalī, 42)

144. "Chemists and physicists have taught us that flame consists of incandescent matter, raised to a high temperature by the process of combustion...and that the flame can exist only so long as the combustion goes on and a sufficiently high temperature is thereby maintained to render the burning matter luminous...The flame is the outward visible sign of certain chemical and physical processes, of the action and reaction between the material which is being burnt and the atmosphere which surrounds it."

(*Outlines of Evolutionary Biology* by Dr. Dendy, p. 2.)

Tarka Saṃgraha mentioned as a material organ[145] and hence a form of matter or Pudgala.

We thus see that the nine realities of the Vaiśeṣikas are covered by the six substances of the Jain philosophy. Another prominent system of thought Vedānta leaves us with Brahma and Māyā without giving any explanation of Space, Time and Causality. With the help of the mysterious mechanism of Māyā it is not possible to build a world-structure of matter and force.

Our conclusion is, therefore, that the six substances or realities of the Jaina thinkers are (nityāvasthitānyarūpāṇi) permanent in nature and fixed in number as the sole constituents of the universe.

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SŪTRA 5.

रूपिणः पुद्गलाः ॥५॥

RŪPIṆAḤ PUDGALĀH (5)

Also in Śvetāmbara Sūtras we read :

"पोग्गलत्थिकायं रूपिकायं"[146]

i.e., Matter is Rūpi, in other words, it has got touch, taste, smell, and colour.

In *Pañcāstikāya Sāra* of Shri Kundakunda we read:

उवभोज्जमिंदिएहिं य इंदियकाया मणो य कम्माणि ।
जं हवदि मुत्तमण्णं तं सव्वं पुग्गलं जाणे ॥[147]

(Tr.—That which can be perceived by the senses or the sense organs, the various kinds of bodies of living beings, the physical Manas or the brain, the Karmic matter are all Mūrta or Rūpi objects. Know that all these are forms of matter or Pudgala).

COMMENTARY

In the above gāthā the author points out the various forms

145. See also *The Hindu Realism*, p. 23.
146. *Sthānāṅga Sūtra*, 5.3.1; *Vyākhyā Prajñapti* 7.10.
147. *Pañcāstikāya Sāra* 89.

of matter. All objects of sense perception have a physical existence; in other words, physical properties such as touch, taste, smell or colour are associated with them. In Jainism five kinds of bodies are enumerated. They are all material and are as follows :—

(1) Audārika Śarīra—Physical bodies of all living creatures whether born from the womb of a mother born otherwise including the microscopic and self-microscopic organisms.

(2) Vaikriyika Śarīra—that which is possessed by the beings of the heaven or those of the hell. It is invisible to normal vision and is capable of transformation in shape or size.

(3) Āhārake Śarīra—A subtle body which is developed by advanced Yogis and can be projected or shot forth to great distances on special occasions.

(4) Taijasa Śarīra—The electrical body whose existence has been varified by scientific experiments. (see pages 56-57 ante.)

(5) Kārmāṇa Śarīra[148]—The inner subtle body which is the seed of all mental and physical activities.

Only the first of these can be perceived by senses, the others are subtle bodies, one subtler than the other in succeeding order. But they are all corporeal.

Then the author has included Dravya Mana[149] in the class of Pudgala and so it is.

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148. It is this subtle material body which is responsible for keeping the soul bound to the confines of the Universe (the Loka) owing to the gravitational forces of matter surrounding on all sides. When Karmic matter is shed off, the soul, being the lightest substance, moves on upwards until it is brought to rest at the top of the Universe owing to the absence of the medium of motion beyond. This is just in accordance with the physical principles. A hydrogen balloon, let free, goes on moving upwards owing to the fact that hydrogen is lighter than the surrounding air and comes to rest at the height where the surrounding atmosphere is all hydrogen. This view is expressed in Sūtras 5 & 6 of Chapter X. of *Tattvārtha Sūtra* :
"तदनन्तरमूर्ध्वं गच्छत्यालोकान्तात् ॥५॥ पूर्वप्रयोगादसंगत्वाद्बन्धच्छेदात्तथागतिपरिणामाच्च" ॥६॥

149. Dravya Mana appears to be identical with the physiological organ, the Heart.

Matter has been divided into six sub-classes as follows:—

अइथूल-थूलं, थूलं, थूल-सुहुमं च, सुहुम-थूलं च ।
सुहुमं अइसुहुमं इदि धरादियं होदि छब्भेयं ॥
भूपव्वदमादीया भणिदा अइथूलथूलमिदि खंधा ।
थूला इदि विण्णेया सप्पीजलतेलमादीया ॥
छायातवमादीया थूलेदरखंधमिदि वियाणाहि ।
सुहुम-थूलेदि भणिया खंधा चउरक्खविसया य ॥
सुहुमा हवंति खंधा पावोग्गा कम्मवग्गणस्स पुणो ।
तव्विवरीया खंधा अइसुहुमा इदि परूवेंदि ॥[150]

(1) Sthūla-sthūla, i.e., *Solids* such as earth, stone and the like.
(2) Sthūla, i.e., *liquids* like molten ghee (butter), water or oil.
(3) Sthūla-Sūkṣma, i.e., *Energy* which manifests itself in forms of heat, light, electricity and magnetism.
(4) Sūkṣma-sthūla, i.e., *Gases* like air and others.
(5) Sūkṣma, i.e., *Fine matter* which is responsible for thought activities and is beyond sense perception.
(6) Sūkṣma-Sūkṣma, i.e., *extrafine matter* such as the streams of single elementary particles, electrons, protons and positrons or of the particles like neutrons which are composed of two elementary particles each, a proton and an electron in close union.

This is the most up-to-date and scientific classification of the kinds of matter. Prior to the discovery of the electron (1876) the physicists and the chemists divided matter into three main classes, solids, liquids and gases. The advent of the theory of relativity and the elucidation of the nature of the electron necessitated an extensive revision in the conception of matter. It was shown that an electron, which is the universal constituent of matter, "is a disembodied atom of electricity free from association with matter as we know it."[151]

To the question "Has energy any weight?" the classicial physics of Newton and Galileo gave a definitely negative answer.

150. *Niyama Sāra*, 21-24.

151. *Magnetism and Electricity* by R. W. Hutchingson, M.Sc. A.M.I.E.E., Vol. II, p. 470.

"But the theory of relativity gives a very different answer. Energy is not weightless, because it has a definite mass......the deductions from the theory of relativity can be confirmed in a certain indirect way and that the outcome of experiment is definitely in favour of that theory......The quantity of heat required to convert one thousand tons of water entirely into steam would weight not quite 1/30 of a gram. It is because the mass which energy represents is so small that energy was for so long regarded as a weightless fluid.

The energy of radiation of the sun also represents a certain mass. Millions of tons of energy are scattered every second through the universe."[152]

After pointing out the exact mathematical relation between mass and energy, viz.,

$$\text{Energy} = \text{mass} \times (\text{velocity of light})^2,$$

the same author proceeds to say that "every mass is a seat of energy ! Not only has energy mass but conversely also every mass has energy...To sum up briefly: the differentiation between energy and mass is discarded. Every mass represents a store of enormous energy and each energy possesses mass, albeit very small".

The author of the *Restless Universe* Professor Max Born has treated this subject beautifully. He says:—

"According to this theory (theory of relativity) mass and energy are essentially the same.[153]

When a man shoots with a gun he feels a recoil. The bullet flies forwards, so the gun must move backwards—(in a similar way)...emission of light in a certain direction leads to a recoil of the body emitting it. For example, we may take the searchlight and provide it with a shutter. If we open this for an instant, a beam of light rays shoots out. Then the searchlight is subject to a recoil like that of the gun.

This is really so is not just a theory but an experimental fact."[154]

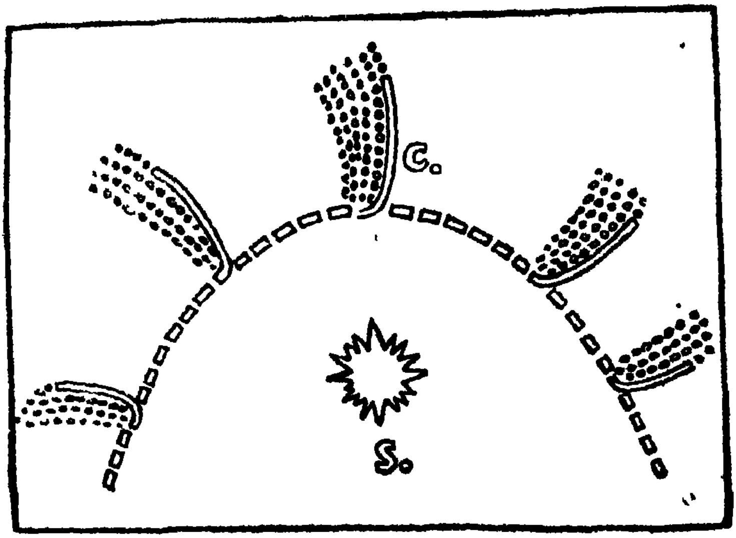
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152. *The World in Modern Science*, p. 77.

153. According to Jaina view the matter and energy are different phases of the same entity called Pudgala for which the search is going on all over the scientific world (See pages 49-50 ante under the heading 'A Note on Pudgala'). It is an experimental fact today that when an electron meets a positron their entire mass is converted into gamma-ray energy.

154. *Restless Universe*, p. 83-86.

This experiment clearly proves that light possesses weight just as a bullet does. Since light is not like a single shot but a continuous stream, it does not give a sudden impulse but it causes impact on the surface on which it falls just like a jet of water or a blast of wind. It is reported that with a sufficiently strong light one could knock a man down. Fig. 9 illustrates how the tails of comets always point away from the sun. This is because a comet is composed of very minute particles which are blown back by the pressure of the light from the sun.



The figure shows the tail of a comet continuously veering round so as to be always opposite the sun, thus verifying the Pudgala nature of Light energy.[155]

Fig. 9

To quote further from the same book :[156]

"There is no doubt that a body losing energy by radiating light does lose mass ; but without necessarily losing particles. The sun loses, in one year, 1,38,00,00,00,000 tons by its radiation.

"If light is absorbed by a body, the body becomes warmer and simultaneously heavier by the mass corresponding to the

155. Recent mathematical calculation shows that this radiation pressure is not strong enough.

156. Vide *Restless Universe.*

light absorbed. Heat energy, therefore, has mass, just as light energy has.

"Every form of energy storage implies a storage of mass, no matter whether the energy be magnetic, chemical or in any other form. Energy and mass are just different names for the same thing. One gram of mass is equivalent to 9×10^{20} ergs ; to obtain this energy from coal we should have to burn nearly 3,000 tons. Unfortunately, matter is not sufficiently obliging to set its mass and so, its energy free.

"Recently, however, cases have been found to occur where this transformation of matter into free energy actually takes place." Every form of matter is convertible into energy. This fact is fully illustrated by the explosion of a hydrogen bomb. Here four nucleii of hydrogen fuse to give one helium nucleius and only a fraction of their mass is converted to energy. But now it has become possible to convert the entire mass into energy by allowing matter to react with anti-matter.[157] The two will entirely cancel each other giving out a spectacular amount of energy.

It is the height of wisdom of Jaina thinkers to have iucluded all forms of energy in class of matter. In fact they have identified matter and energy under the general name Pudgala. One form of energy can be changed into another form because they are fundamentally the modifications of the same dravya Pudgala. This intra-convertibility of heat into light, light into sound, sound into electricity and so on is the secret of all wonders of modern science. One example of the recording and reproduction of taking films will illustrate this point.

The microphone which hangs over the head of an actor in the studio converts the sound waves into electric current ; this current is then passed through a special lamp where the electric

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157. Anti-matter is the opposite of matter. An anti-matter atom has a negatively charged nucleius containing anti-protons. Positively charged particles-positrons or anti-electrons—revolve in the orbits, whereas in a normal atom of matter the electrons move round the positive charge in the centre.

Anti-matter is obtained from nuclear accelerators. In the world's largest particle accelerator at Serpukhov, USSR, the Soviet Scientists have obtained anti-helium—the most complex anti-matter ever produced. The same experiments have yielded anti-deuterium also. In the language of Jaina Śāstras anti-matter is also a form of Pudgala.

current is changed into light. This light falls on the film and gives rise to what is known as the 'sound record'. Notice the changes; sound into electricity and electricity into light.

In order to reproduce the sound from the film, the reverse process is adopted. Light transmitted through the sound-record falls on a 'photo-electric cell' which changes light into a current of electricity and this current after passing through a loud-speaker generates the original sound. Notice the changes again: light is converted into electricity and electricity into sound.

The physicists have regarded all forms of energy as one substance and just as a sugar toy in the form of an elephant can be easily converted into another apparently divergent form of a palace, in the same way instruments have been devised by scientists to convert one form of Pudgala into another form. In no other system of Indian thought this beautiful concept of Pudgala (energy and matter) exists.

Let us now take up one interesting point which may seem curious and incomprehensible. The Jaina thinkers have included shadows and images formed by lenses and mirrors[158] in the Sthūla-Sūkṣma class of Pudgala i.e., they regard it as a manifestation of energy (Vide p. 65 ante). The formation of shadows is explained by the physicists as follows :—

An opaque obstacle in the path of the rays of light casts a shadow because the rays are obstructed and are unable to enter the region of the shadow. The images formed by lenses and mirrors are of two kinds called virtual and real. The example of a virtual image is the image seen in a looking glass, whereas the example of the latter is the images on a cinema screen. In the case of a virtual image the rays appear to come from the image whereas in the case of a real image the rays do actually come from it. Thus it is clear that energy manifests itself in the form of shadows and images, virtual and real.

Also there is evidence to show that a dark space is not entirely devoid of energy. We read on page 137 of the *Restless Universe* :

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158. "छाया प्रकाशावरणनिमित्ता, सा द्वेधा, वर्णादिविकारपरिणता प्रतिबिम्बमात्रात्मिका चेति,"

(Sarvārtha Siddhi, 5.24)

"Instead of looking at a system of interference bands[159] with the eye, it is possible to make a small counting apparatus pass over them and count the electrons photo-electrically liberated by them in the tube. Then we obtain many electron impacts just when the counting tube is over a bright band, and *few when it is over a dark band.*"

With regard to the sound energy the Jaina thinkers have included it in the Sūkṣma-Sthūla class of Pudgala because it cannot be seen with the eyes but can be perceived with the help of the auricular organ, whereas the shadows are included in the class Sthūla-Sūkśma. It should be noted, however, that the two classes are overlapping as do their names. Prof. A. Chakravarti observes in this connection as follows :

"Unlike the other Indian systems of thought which associate sound with Ākāśa Jain system explains the sound as due to the violent contact of one physical object with the other. It is said to be generated by one skandha (molecule) knocking against another skandha. Sound is the agitation set up by this knock. It is on account of this theory of sound that the system speaks of an atom or Paramāṇu as *unsounding by itself.*"[160] This idea is expressed in gāthās of *Pañcāstikāya Sāra.*

आदेशमत्तमुत्तो धादुचदुक्कस्स कारणं जो दु ।
सो णेओ परमाणू परिणामगुणो सयमसद्दो ॥
सद्दो खंधप्पभवो खंधो परमाणुसंगसंघादो ।
पुट्ठेषु तेषु जायदि सद्दो उप्पादगो णियदो ॥[161]

The atom is defined as having a perceptual form. the cause of elements like earth, fire, water and air and unsounding. The cause of sound natural or artificial has been pointed out to be the striking of molecules against one another.

This is just the scientific view of the generation of sound. 'Sound does not travel in vacuum' is a famous experiment which is shown to every school-boy. If sound were generated by Ākāśa or Ether as is supposed by the author of the Vaiśeṣika

159. When one wave of light energy interferes with another under certain conditions, alternate bright and dark bands are formed called interference bands.

160. Vide *A Philosophical Introduction to Pañcāstikāya Sāra*, p. XXXVIII.

161. *Pañcāstikāya Sāra*, gāthās 85-86.

School, sound would be still heard for æther or Ākāśa is present in the vacuous space also.

The view of science is expressed by R. S. Willows in his *Text-book of Physics :*

"It is a common experience that a source of sound is in a state of vibration. For example, the prongs of a tuning-fork, a bell, the strings of a piano and the air in an organ pipe are all in a state of vibration when they are producing sound."[162]

Again he says "Light waves can travel through vacuo but sound waves require a material medium."[163]

We now take up the discussion of another form of Pudgala known as Karmic matter. It is regarded as a subtle form of matter which is drawn in towards the soul as a result of our desires, passions and other thought activities. It is well-known that our thoughts and deeds affect our character and modify the tendencies of our souls. Therefore Karma should be regarded as some form of vital force, for it would be quite illogical to think that the soul could be influenced by something which has no substantiveness. Since force is unthinkable apart from matter, Karmic matter has been regarded as the agent through which our thoughts and actions affect the soul.

The existence of Karmic matter is partly established by the recent investigations of scientists in America. We reproduce below certain portions of the reports[164] recently presented before the Federation of American Societies for Experimental Biology:

The activities of mind and matter constituted a super-radio, with the quintillions of living cells sending out their individual waves to be tuned in quadrillions of receiving sets in the brain......Professor Hallowell Davis of Harvard Medical School described five different kinds of waves that have now been found

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162. *Text Book of Physics*, p. 249.

163. Ibid., p. 261.

164. In the issue of the '*Discovery*' (London) for December 1973 the apparatus for measuring brain-waves has been described as a valve amplifier "which is regular during normal thought but erratic if any sudden shock disturbs the mind. Mr. Grey Walters has found it possible with this apparatus to measure the normal and abnormal intensity of thought..."

—*Recent Advances in Biophysics* by F. W. Britton, D.Sc.

Today brain waves are being freely recorded on paper and the record is called *encephalogram.*

to be emanating from the brain......The *encephalogram* (electrical record of the brain-waves on paper) *taken under standard conditions seems to be* quite characteristic for a given person......The brain and nerves, stated Professor, Davis, generated electrical waves which could be detected by means of sensitive amplifiers.[165]

That the *body's electrical impulses are connected with a chemical activity*, the electrical impulses being associated with the secretion by the nerve-endings of a powerful drug known as *acetylcholine*, was brought out in a paper by Dr. V. E. Henderson of the Department of Pharmacology, Toronto University. It was for work in this field that Professor Otto Loewi of Graz, Austria, and Sir Henry Dale of London received the Nobel Prize in medicine last winter.

Professor Leo Loeb of the Department of Pathology, Washington University School of Medicine, St. Louis, presented a paper on the 'Biological Basis of Individuality.' He offered evidence for the existence of substances in each individual higher organism, man as well as animals and birds, which bring about the unification of its many parts.

"These 'individualityd ifferentials' are genetically determined and therefore transmitted by heredity but they are represented by substances which develop in the course of phylogenetic and embroynal evolution," said Dr. Loeb.

These reports of the American doctors establish the fact that our thoughts and emotions give rise to electrical waves in the brain which tune in foreign energy waves just as the waves generated in a radio receiving set tune in electrical waves of foreign stations. This is what a Jaina would call *āsrava* (i.e. influx) or Karmic matter into the soul. That the influx of these electric impulses is connected with chemical activity is a clear index of the fact that our Karmas accumulate round the soul in the form of fine dust. Thus the existence of Karmic matter is to a very great extent established by experimental science.

The extra-fine matter Sūkṣma-Sūkṣma we have interpreted as streams of indivisible elementary units of matter called electrons, protons, positrons and neutrons of modern science. The reason for this is this :

165. Reproduced from *Hindustan Times*, July 3, 1937. William L. Laurence's article under the caption 'Man's Mind Traced by Electricity.'

"अत्यंतसूक्ष्मा: कर्मवर्गणाभ्योऽघो द्व्यणुकस्कंधपर्यन्ता: सूक्ष्मसूक्ष्मा इति।"

i.e. the extrafine matter has been said to be composed of Skandhas made up of ***one or two Paramāṇus and no more***, and a ***Paramāṇu*** has been defined as:

"जद्दव्वं अविभागी, तं परमाणुं विआणाहि"[166]

(The last particle of matter, which cannot be sub-divided any further by any means whatsoever, is a Paramāṇu.)

Also in Sūtra 27 of *Tattvārtha Sūtra* (Ch. V) we have

"भेदादणु:"—(भेदात् अणु: उत्पद्यते)

i.e., a Paramāṇu is obtained by division of matter to an infinite extent, not by union.

Or from *Tattvārtha Rājavārtika* (5.11)

"ततोऽल्पपरिमाणाभावात्"।

i.e., there is nothing smaller than Paramāṇu.

It follows that a Paramāṇu cannot be interpreted and should not be interpreted as the *atom of modern chemistry* although originally the word was invented by the Greek philosopher Democritus (420 B.C.) to denote something which could not be sub-divided. John Dalton, the great propounder of the Atomic Theory of matter, declared in the year 1808: "Thou knowest no man can split atom." But since the atom of chemistry has now been proved to be a conglomeration of protons, neutrons and electrons, I venture to suggest that Paramāṇus are really these elementary particles which exist by themselves, or if at any future date the quark is discovered that should then be interpreted as the Paramāṇu of the Jainas. Neutron[167] is composed of

166. *Sarvārtha Siddhi* on Sūtra 5.25.

167. The extra-fine character of the neutrons is exhibited in the fact that they cannot be kept confined in a vessel of glass, metal or rubber. They slip through the walls of the vessel. Their velocity is about 1,000 miles per second. They can penetrate a mile's thickness of air and several feet of lead, which even X-rays cannot. Their piercing power is so great that, according to one scientist, if a cannon ball could be made out of them it would pierce 75 million miles of steel plate. They have been found to be a powerful weapon in the artificial breaking of Skandhas. Neutrons exist in the air we breath only one part in 160,000,000,000. Neutrons are produced when aluminium is bombarded by alpha particles from radio-active substances.

two Paramāṇus and hence included in the category of extra-fine matter.

Before concluding the commentary on this Sūtra it would be well to quote the Sānkhya view of matter. Against the declaration of the Jainas' Rūpiṇaḥ Pudgalāḥ (रूपिण: पुद्गला:), the Sānkhya school regards Prakṛti or Nature as *arūpi* i.e. formless.

"The manifested world is traced to an unmanifested ground, the Prakṛti, which is conceived as formless, and undifferentiated, limitless and ubiquitous, indestructible and undecaying, without beginning and without end. The unit of this Prakṛti is a mere abstraction; it is in reality an undifferentiated manifold, an indeterminate, infinite continuum of infinitesimal Reals."[168]

This view is quite in conformity with the fact that ultimately all kind of matter and different forms of energy are reducible to a single form of Pudgala, the invisible fundamental particles of electricity electrons, protons, positrons and neutrons being the extra-fine Sūkṣma-Sūkṣma form of it. Though these particles are invisible to the eyes, they can be perceived by other means and also give rise to concrete form of matter. Hence Jaina thinkers have said 'Rūpiṇaḥ Pudgalāḥ'. (i.e. Matter is Rūpī, in other words, it has got touch, taste, smell, and colour).

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SŪTRA 6.

आ-आकाशादेकद्रव्याणि ॥६॥

Ā-ĀKĀŚĀDEKADRAVYĀṆI. (6)

(आ-आकाशात् एकद्रव्याणि भवन्ति) ॥

Also in Uttarādhyayana Sūtra we read:

"धम्मो अधम्मो आगासं दव्वं इक्किक्कमाहियं"[169]

Referring to the first Sūtra *'ajīvakāyā dharmādharmākāśa-pudgalāḥ'* the author says that the Dravyas enumerated there up to Ākāśa (i.e., Dharma, Adharma and Ākāśa) are one continuum each i.e., indivisible wholes.

168. *Introduction to Hindu Chemistry* by Sir P. C. Ray.
169. Uttarādhayana Sūtra, 28.8.

The earliest recognition of the motive principle called Dharma Dravya is found in the Jaina literature alone but ancient Greek philosophers also recognised its necessity in the scheme of the universe. Anaxagoras in his work *On Nature* (450 B.C.) introduced for the first time in the Western world the idea of a medium necessary for motion and called it 'the cause of all changes' : Aristotle, called it æther.[170] In the standard work of Dr. J. W. Mellor, quoted before, we read as follows:—

"Aristotle added a fifth element, æther, more divine than the others (earth, water, air and fire) and which pervaded all things and was in perpetual motion. The ancient Hindu philosophers also had a fifth element, which, in their system, was *wrongly supposed to be a medium for propagating sound*, etc., and which, in consequence, *had something in common with the modern concept of an æther pervading all space.*"[171]

The non-atomic continuous nature of æther has been recognised by science in the following words:—

"Ether is not composed of atoms. If it be supposed that it consists of minute homogeneous atoms, it must be further supposed that there is something else between these atoms, either 'empty space or a third completely unknown medium, a purely hypothetical 'inter ether'; the question as to the nature of this brings us back to the original difficulty, and so on *ad infinitum*. As the idea of an empty space and an action at a distance is scarcely possible in the present condition of our knowledge...I postulate for æther a special structure which is not atomistic, like that of ponderable matter."[172]

"Huyghens introduced the conception of the æther—a weightless, transparent medium which permeates the entire universe."[173]

"At the time when that conception (that of electric fluid) arose, it had become the fashion to introduce into science, in addition to matter of different kinds which possessed weight, substances which one might call imponderable,—i.e., weightless fluids. Heat, electricity, magnetism and the æther were some of

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170. See '*Greek Thinkers*' by T. Gompertz, London, and also '*Early Greek Philosophy*' by J. Burnet, London.

171. *Inorganic & Theoretical Chemistry* by J. W. Mellor, Vol. I, p. 33.

172. *The Riddle of the Universe* by Prof. Haeckal, Chap. XII.

173. *The World in Modern Science* by Infeld, p. 30.

the members of this imponderable family. *Nowadays, the ether is the only member of* this family which has survived,......"[174]

"Material media are penetrated by æther, their molecules being surrounded by it much as the leaves of a tree are surrounded by the air." (For more details about æther read pages 19-23 ante.)

These quotations establish the nature of æther as a non-atomic continuous medium.

We have already shown that the modern science has postulated the existence of gravitation in order to account for the stability of the macroscopic world and the existence of a similar electromagnetic forces in the case of the microscopic world like that of the atoms and the molecules. Those who are in touch with the recent developments in Physics know that the great physicist Prof. Einstein has already given out his Unified Field theory of gravitation and electromagnetism as referred to on page 32 ante (footnote 81). Several theories are in the field at present and one which will be found convincing in all repects will be accepted. Then we will be left with one Adharma Dravya, the principle of stability for the macroscopic as well as for the microscopic world.

In the meantime let us see what is the present view of science on this point. As mentioned on pages 32-33 ante the physicists have at every step felt that necessity of assuming a medium for the operation of gravitation but they never formulated it in clear words. However in the case of electromagnetic forces, which are a counterpart of gravitation, a medium was recognized by the great 'Prince of experimenters' Sir Michael Faraday and the same conception is still in force. Prof. Max Born states that "at the beginning of the 19th century most physicists, particularly on the continent, asserted that the electric force acts through the empty space between two charges ('action at a distance'). Faraday, however, developed the idea that the electric field is due to something which happens in the space between the charges ('action through a medium')."[175]

With regard to the continuity of space, the space of the mathematician of today is undoubtedly an unbroken continuum; even the Dictionary meaning of 'space' conveys the same idea.

174. Ibid., p. 68.

175. *Restless Universe*, p. 140.

The Standard Oxford Dictionary defines space as a "continuous extension viewed with or without reference to the existence of objects within it."

(Fore more details about Space read pages 35-42 ante).

It is thus evident that Dharma, Adharma and Ākāśa are indivisible extensions as mentioned in the above Sūtra.

Until lately science regarded space as continuous medium but now the atomic theory of space is appearing on the horizon. Richard Feynman, Nobel Laureat of 1965 uttered the following words in a recent lecture delivered in America: "I believe that the theory that space is continuous is wrong (But if I knew the answers), I should finish this lecture with a new law." Lawrence Horstman in his article 'Infinitesimal'[176] says that the theory of atomic space is still unproved.

If space is composed of a huge number of very small (but finite) unit cells which cannot be sub-divided in any way, we shall have to postulate some other medium between the individual elementary cells of space. The Jaina view is that in reality space is continuous but for practical purposes we imagine it to be divided into space-points called Pradeśas.

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SŪTRA 7.

निष्क्रियाणि च ॥७॥

NIṢKRIYĀṆI CA (7)

(आ-आकाशात् निष्क्रियाणि च भवन्ति ।)

(Dharma, Adharma and Ākāśa, these three are not capable of moving from one place to another.)

Not only these three but also the time is incapable of motion:

(कालस्यापि सक्रियत्वमिति चेत्, न)[177]

The learned author of Sarvārthasiddhi has raised a very interesting point in the commentary on this Sūtra. He says:

176. *Science Today*, March 1973.

177. *Sarvārtha Siddhi* on Tattvārtha Sūtra 5.7.

"धर्मादीनि द्रव्याणि यदि निष्क्रियाणि ततस्तेषामुत्पादो न भवेत् । उत्पादाभावाच्च व्ययाभाव इति ॥"[178]

(Tr.—If Dravyas, Dharma, etc., are incapable of motion from place to place how is Utpāda and Vyaya maintained which is the chief characteristic of a substance). (See page 51 ante.) From the very nature of definition of a substance it follows that generation (Utpāda) and decay (Vyava) must go on in these Dravyas in some form or the other. The same author answers the point saying:

"अनन्तानाम् अगुरुलघुगुणानामागमप्रामाण्यादभ्युपगम्यमानानां षट्स्थानपतितया वृद्ध्या हान्या च प्रवर्तमानानां स्वभावादेतेषामुत्पादो व्ययश्च ॥"

Amongst the six common attributes of substances, viz., Astitva (indestructibility), Vastutva (functionality), Dravyatva (changeability), Prameyatva (capacity of being the subject of knowledge), Agurulaghutva (individuality) and Pradeśatva (capacity of having some form), the Agurulaghu (अगुरुलघु) attribute is such that an imperceptible rythmic rise and fall is constantly taking place in its parts in six *different steps* and these natural rythms rising and decaying produce Utpâda and Vyaya. Agurulaghu attribute is said to be responsible for maintaining the individuality of the substance and its characteristic properties. The *ṣaḍguṇī hānivṛddhi* or six different steps of infinitesimal changes,—an entirely ingenious idea of the Jaina thinkers,—can be explained as follows:—

Enumeration has been divided into three classes: (i) Sankhyāta, i.e., countable; (ii) Asankhyāta, i.e., countless, and (iii) Ananta, i.e., infinite.

To explain the full meaning of these three classes with their 21 sub-divisions is a long mathematics and would carry us far beyond the present theme. It is enough to mention the distinction between countless and infinite. The former has a limit, though it is beyond the power of even an omniscient being[179] to count them, the latter is inexhaustible and without limits.

178. Ibid.

179. "संख्याविशेषातीतत्वादसंख्येया:"

"तदनुपलब्धेरसर्वज्ञत्वप्रसंग इतिचेन्न, तेनात्मनावसितत्वात् ।"

(Tattvārtha Rājavārtika, 5.8.)

To give an example, the number of unitary cells of space (Pradeśas) in Loka is countless since Loka is finite but the number of Pradeśas in the space beyond is infinite, since Aloka has no limits.

The six steps upwards are: (i) Infinitesimal increase,[180] (ii) increase by a countless fraction, (iii) increase by a countable fraction, (iv) increase countable times, (v) increase countless times, (vi) increase infinite times. (Note that these steps are in ascending order of magnitude.) The six steps along the descent are in exactly reverse order so that the whole series of changes constitutes, what in science we call, a reversible cycle. The hypothetical numerical example given below will make the point more clear:

Suppose there is a number 1024; let the countable, the countless and the infinite be represented respectively by 2, 4 and 8; then the number will undergo the rise and fall like this:

(i) Infinitesimal increase: $1024+\frac{1024}{8}=1152$

(ii) Countless fraction increase: $1152+\frac{1024}{4}=1408$

(iii) Countable fraction increase: $1408+\frac{1024}{2}=1920$

(iv) Countable times increase: $1920+(1024\times 2)=3968$

(v) Countless times increase: $3968+(1024\times 4)=8064$

(vi) Infinite times increase: $8064+(1024\times 8)=16256$

(vii) Infinite fraction decrease: $16256-\frac{1024}{8}=16128$

(viii) Countless fraction decrease: $16128-\frac{1024}{4}=15872$

(ix) Countable fraction decrease: $15872-\frac{1024}{2}=15360$

(x) Countable times decrease: $15360-(1024\times 2)=13312$

(xi) Countless times decrease: $13312-(1024\times 4)=9216$

(xii) Infinite times decrease: $9216-(1024\times 8)=1024$

This phenomenon may be likened to a stationary *wave-motion* in which the system of waves alternately waxes and wanes without progression in either direction. The characteristic of stationary wave-motion is described by Barton as follows:

180. In the language of calculus it means increase from X to X+8X.

"To all appearances the wave-motion seems to be stationary in position. The wave-form shrinks to a straight line by proportional diminution of all its ordinates. It then expands proportionally all the ordinates being now reversed in sign, again shrinks and so forth."

In the Jaina work *Ālāpa Paddhati* the phenomenon is compared to the ripples growing and decaying on the surface of a sea thus making the analogy with a stationary wave-motion still more striking.

Thus we shall see that Jainism regards the media of motion and rest and the Space-Time as unmoving with these natural pulsations existing in them. Can we not think that these pulsations are generated by the movement of various material bodies and particles in space? The attempts of scientists to detect æther were based on this conception. We have referred to the famous Michelson-Morely experiment on page 21 ante. The argument was this:

"Just as the æroplane passengers observe a strong head-wind, so there must be an ether-wind blowing past the earth............ The light-waves on the earth must be blown about by the ether-wind. Accordingly as they travel with or against the direction of the ether-wind or at right-angles to it, their velocity will be different. The effect is only a very minute one......"[181]

As we have seen (in pages 21-22 ante) sometimes negative and some-times positive result has been obtained, the latter, however, has not been unequivocally confirmed. The last conclusion is there-fore that the earth is moving through a fixed ether. If, however, a positive result is obtained, as prophesied by the great Indian mathematician late Sir S. M. Sulaiman and as some more precise experiments published in the American Physical Review (Feb. 15, 1935) testify, it would be a brilliant confirmation of the *ṣaḍguṇī hānivṛddhi* theory of the Jainas.

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181. *Restless Universe* by Max Born, p. 75.

SŪTRA 8.

असंख्येयाः प्रदेशा धर्माधर्मैकजीवानाम् ॥८॥

ASAṀKHYEYĀḤ PRADEŚĀ DHARMĀ-DHARMAIKAJĪVĀNĀṀ. (8)

(धर्म-अधर्म-एकजीवानामसंख्येयाः प्रदेशा भवन्ति ।)

In Śvetāmbara text this Sūtra has been broken into two :

असंख्येयाः प्रदेशा धर्माधर्मयोः ॥७॥

जीवस्य च ॥८॥

Also in a Śvetāmbara work we have :

"चत्तारि पएसग्गेणं तुल्ला पण्णत्ता, तं जहा—

धम्मत्थिकाए, अधम्मत्थिकाए, लोगागासे, एगजीवे" ॥[182]

(Tr.—There are countless Pradeśas[183], space-points in Dharma, Adharma and a single soul.)

The same idea is expressed in *Tattvārtha Sāra* :

एकस्य जीवद्रव्यस्य धर्माधर्मास्तिकाययोः ।

असंख्येयप्रदेशत्वमेतेषां कथितं पृथक् ॥"[184]

Or in *Niyamasāra :*

धम्माधम्मस्स पुणो जीवस्स असंखदेसा हु ॥[185]

(*Tr.*—There are countless space-points in the medium of motion, medium of rest and in each individual soul.)

Pradeśa is the unit of three-dimensional space which is employed in the measurement of the dimensions of the substances in the universe. Taking this as the measure the number of Pradeśas in the universe is said to be countless. The media of motion and rest are co-extensive[186] with the universe

182. *Sthānanga Sūtra*, 4.3.495.

183. For definition of Pradeśa and its full explanation see pages 3-14 ante.

184. *Tattvārtha Sāra*, 3.19.

185. *Niyama Sāra*, 35.

186. लोकाकाशे समस्तेऽपि धर्माधर्मास्तिकाययोः ।
तिलेषु तैलवत् प्राहुरवगाहं महर्षयः ॥ *(Tattvārtha Sāra, 3.23)*

(Dharma and Adharma pervade all parts of the universe as oil pervades the whole portion of mustard seed.

(Lokākāśa) and have thus a similar number of Pradeśas. Souls are found in different bodies of different dimensions in their mundane state but each one of these has the capacity of expanding and filling the whole universe.[187] Thus the number of Pradeśas in each soul is equal to the number of those in the universe, i.e., countless or innumerable.

It should not be thought at this stage that the mention of a number of Pradeśas in the universe as countless introduces an uncertainty with regard to the size of the universe. Although Dharma, and Adharma are *continuous* media, it is only for explaining certain physical and psychical phenomena that this idea of parts is introduced. The Jaina thinkers have given a definite figure for the volume of the universe ; 239 cubic Rajjus[188] according to Śwetāmbars, and 343 cubic Rajjus, according to Digambaras.

It would not be out of place here to give an idea of the 'Countless' as enunciated by Jaina writers. Suppose there is an interminable series of oceans and continents surrounding each other on the flat earth in the form of concentric rings with a minimum diameter of 100,000 yojanas (one yojana = 4,000 miles[189]),

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187. "संहाराच्च विसर्पाच्च प्रदेशानां प्रदीपवत् ।
जीवस्तु तदसंख्येयभागादीनवगाहते ॥"

(Tattvārtha Sāra, 3.14)

(*Tr.*—By contraction and expansion of its Predeśas a soul is capable of occupying the countless Pradeśas of the universe, just like the flame of a lamp whose light can fill either a small room or a big hall.)

188. Rajju (=chain, a linear astrophysical measure), is, according to Colebrook, the distance which a Deva (god) flies in six months at the rate of 2,057,152 yojanas in one Kṣaṇa (instant of time = ¼ second).

(Quoted by Von Glassenapp in '*Der Jainismus*.')

Compare this unit with the modern unit of astronomical distances, viz., the light-year which has been defined as the distance which a beam of light travels in one year at the rate of 186,000 miles per second. Is not the similarity very striking?

189. In the famous Hindu work Aṣṭādhyāyi by the great grammarian Pāṇini we come accross the following scale of distances.

12 Angula = 1 Vitastā (span = 9″)

8 Vitasti = 1 Dhanu (= 6′).

4000 Dhanu = 1 yojana (24000′ or 4.5 miles approx.)

In *Lalitavistara*, a Buddhistic work of about 1st century, we find this scale repeated.

In an article entitled '*Regveda and the Velocity of Light*' by Prof. R. Krishnamurthy, M.A. (*Astrological Magazine*, January 1949) a very learned

which goes on doubling itself in the case of each succeeding continent and sea. Let there be four pits A, B, C, D each 1,000 yojanas deep and of the diameter of the smallest continent, viz., 100,000 yojanas. If the pit A is filled with mustard seeds up to the top and above it in conical formation, calculation shows that the pit will hold 197,711,293,845,131,636,363, 636,363,636,363,636,363,636,363,636,363,6.4/11 seeds of mustard.

Suppose we empty this pit by dropping one seed in each of the continents and oceans, which, as have supposed, form an interminable chain. At the place where the last seed is dropped we dig another pit 1,000 yojans deep, as before and of the diameter of this ocean or continent, whatever it be and fill it to the top as before. Empty this pit again in the same manner beginning with the continent or ocean next to one in which this pit is situated. Stop where the last seed is dropped and dig a pit of the same depth as before but of the diameter of the ocean or the continent itself. Remember that the diameter is doubling as we go to the succeeding ocean or the continent. This process will be continued until the pit D is filled in the manner indicated in the next paragraph. Let the pits dug so far be called the pits of A series.

Each time that a pit of A series is dug one mustard seed must be thrown in B until the latter is full to the top as indicated in the case of A. When this is achieved, the same process

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and reliable computation on the magnitude of a *yojana* is given where on the basis of Velocity of light the value has been calculated as $\frac{100}{11} = \left(9\frac{1}{11}\right)$ miles.

This is confirmed by the following scale;—

12 Angulas = 1 Vitasti or span = 9″
2 Vitastis = 1 Hasta or Cubit
4 Hastas = 1 Daṇḍa or Staff = 6′
2000 Daṇḍas = 1 Kośa = 12000′ = $\frac{25}{11}$ miles
Kośa = 1 yojana = $\frac{100}{11}$ miles

(*Science Today*, April, 1974)

The idea of a smaller yojana for measuring the size of the bodies and a Mahāyojana of 4000 miles for measuring lands and seas is found only in jaina literature and nowhere else.

of traversing the continents and oceans of ever-increasing diameter and digging the pits is to be continued. Let the pits now dug be called the pits of B series. Each time that a pit of B series is dug one seed must be thrown into the pit C. The whole process is to be repeated until the pit D is filled. Let the number of seeds in the last pit of C series when D is full be represented by x.

Then $(x^x)^2$ is called the Minimum Ultimate countless. The Maximum Ultimate Countless is Preliminary Infinity minus one. The idea of infinity is given in connection with Sūtra 9.

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SŪTRA 9.

आकाशस्यानन्ताः ॥९॥

ĀKĀŚASYĀNANTĀḤ (9)

(आकाशस्यानन्ताः प्रदेशाः सन्ति ।)

Also in Śvetāmbara work we have :

"आगासत्थिकाए पएसट्टयाए अणंतगुणे" ।[190]

(Tr.—The number of Pradeśas in Space is infinite.)

The conception of Infinity, according to Jainism, is as follows :—

Raise the quantity $(x^x)^2$ to its own power ; then raise the result so obtained to its own power and repeat this process $(x^x)^2$ times. Let the final number be denoted by x_1.

Again raise x_1, to the power x_1, and the result obtained to its own power and continue the process $(x_1^{x_1})$ times. Let the number now obtained be denoted by x_2.

Repeat the whole operation a second time, i.e., $(x_2^{x_2})$, then $(\text{Result})^{\text{Result}}$ to be continued $(x_2^{x_2})$ times. Let the result be now denoted by x_3.

Again $(x_3^{x_3})$; then $(\text{Result})^{\text{Result}}$ to be continued $(x_3^{x_3})$ times. Suppose it gives the number x_4.

190. *Prajñāpanā*, pada 3, Sūtra 271.

The process of arriving at x_4 from x_1, is given the technical name (*śalākātrayanisṭhāpana*). Since we shall have to resort to this process several times in reaching the Infinity, we shall for the sake of simplicity call it the S.T.N. process. To x_4 add the following numbers :

(1) Countless Pradeśas of Dharma Dravya.
(2) „ „ Adharma Dravya.
(3) „ „ a single soul in fullest expansion, i.e., filling the whole universe.
(4) Countless Pradeśas of Space occupied by Loka, i.e., excluding Aloka.
(5) The number of souls in ordinary vegetation which is innumerable times greater than the number of Pradeśas in the Loka.
(6) The number of souls in vegetable parasitic groups which is countless time greater than the number in (5).

Let the number obtained after addition of these six quantities be denoted by (x_4+a).

Subject the number to S.T.N. process and let the result be denoted by x_5.

To the number x_5 add the following :—

(1) The countless number of moments in a cycle of time. (Cycle of time is explained in Sūtra 39) ;
(2) the countless modifications of consciousness ;[191]
(3) the innumerable degrees of intensity of passions ;
(4) The still innumerably greater number of soul vibrations associated with the activities of the mind, speech and the body.

Let the sum be denoted by (x_5+b).

Subjecting (x_5+b) to S.T.N. process, suppose we get x_6. (This number is called Preliminary Infinity.)[192]

Let $(x_6)^{x_6}$ be denoted by x_7, and

$$\left\{ (x_7)^{x_7} \right\}^{(x_7)^{x_7}} \text{ by } x_8.$$

191. For details of (2), (3) and (4) read *Gommata-Sāra*, Jīvakāṇḍa, edited by J. L. Jaini, S.B.J., Vol. V.

192. x_6 minus one is 'Maximum ultimate countless' (See page 84 ante).

Subject x_8 to S.T.N. process and let the result be x_9.

To x_9 add the following quantities :

(1) The number of souls which has attained Nirvāṇa ; this number, although infinite, is infinitely smaller than the total number of souls in the universe.

(2) The number of undeveloped souls (akin to bacteria and unicellular organisms of modern biology) which is infinitely greater than the number in (1).

(3) The number of vegetable souls again infinitely greater than the number in (1).

(4) Number of atoms of matter, which is infinitely greater than the total number of souls.

(5) The number representing the moments of time, infinitely greater than the number of atoms of matter.

(6) The number of points of space, again infinitely infinite.

Let the sum be denoted by (x_9+c).

Subject (x_9+c) again to S.T.N. process and denote the result by x_{10}.

To x_{10} add :

(1) The infinitely infinite[193] of qualities of Dharma Dravya, and

(2) ditto for the Adharma Dravya.

Let the sum be denoted by $(x_{10}+d)$.

Subjecting this number to S.T.N. process we arrive at infinity, for which the mathematical symbol is ∞.

This infinity of Jainas comprises the infinite existing substances and their compounds as well as their infinite states and modifications, and is therefore the 'true' infinity.

193. It is the change in these shades which has been referred to in pages 78-80 ante.

SŪTRA 10.

संख्येयासंख्येयाश्च पुद्गलानाम् ॥१०॥

SANKHYEYĀSANKHYEYĀŚCA PUDGALĀNĀṂ (10)

(संख्येया असंख्येयाश्च (अनन्ताः अनन्तानन्ताः) पुद्गलानाम् प्रदेशाः भवन्ति ।)

(Tr.—Matter consists of numerable, innumerable and infinite parts according as we consider the different molecular combinations.)

Evidences from other sources may be quoted :

"मुत्ते तिविह पदेसा"[194]

(Pudgala has pradeśas which are numerable, innumerable and infinite.)

संखेज्जासंखेज्जाणंतपदेसा हवंति मुत्तस्स ॥[195]

The scientific division of Pudgala is as follows :

(1) Concrete and (2) invisible.

The concrete form we call Matter and the invisible form, Energy.

Matter is further divided into solids, liquids, and gases. All these three forms of matter consist of molecules (Skandhas) and atoms (Skandha-deśas)[196]. Atoms are again an assemblage of indivisible elementary particles (परमाणवः), protons and electrons and their combinations. The number of electrons in the universe has been estimated by Professor Einstein to be
129000000000000000000000000000000000000000000000
0000000000000000000000

194. *Dravya Saṃgraha*, 25.

195. *Niyama Sāra*, 35.

196. खंधा य खंधदेसा खंधपदेसा य हुंति परमाणू ।
इदि ते चदुव्वियप्पा पुग्गलकाया मुणेयव्वा ॥

(Pañcāstikāyasāra, 80)

196. (Matter is composed of molecules, atoms, ionised atoms and invisible elementary particles, such electrons, protons, positrons and heavy electrons of modern science.

For 'ionised atoms' read page 12 ante. Heavy electron, which is 50 times heavier than the ordinary electron, is a recent discovery. (*Science and Culture*, November 1937).

(i.e., 129 followed by 77 chiphers or 80 digits in all.)[197]

Now this is a finite number although very huge. The number of other elementary particles has not been estimated. Then there are the condensed forms of matter, such as those referred to in page 13-14 ante the nuclear matter as it is called weighing 620 tons to a cubic inch—in which there is an extremely close packing of particles beyond human estimation ? Then there are electrons of *negative mass* (see page 96) which do not in any way betray their existence, those which have retired for good from the drama of the universe and whose presence cannot be detected by any measurements whatsoever, thus rendering it impossible to count their number. So the author of the Sūtra says; the number of parts into which matter and energy is divided may be finite or infinite according to the different considerations.

There seems to be an apparent contradiction between this and the 8th Sūtra. The latter says that the number of Pradeśas (Space-points) in the media of motion and rest is only countless whereas according to the present Sūtra the number of Pradeśas in Pudgala Dravya may be infinite. As has been mentioned several times the media of motion and rest (Dharma and Adharma) are co-extensive with the Loka, the universe. Hence the number of Pradeśas in the universe also is 'countless'. The question therefore arises : "How can an infinite number of pudgala particles be accommodated in 'countless' pradeśas of the universe ? The question would have been quite valid if all the infinite particles were in a free state but it is not so. A tiny piece of fuel on combustion gives rise to an enormous volume of smoke particles; a quantity of water when converted into steam occupies a volume about 1,700 times greater than the original volume, a saccharin pill compresses within itself the particles of sweetness which several lumps of sugar would possess, the pollen concentrates in itself the particles of fragrance which occupy a very large volume when they fly in space. And above all there is the tremendous concentration of stripped

197. Quoted from the Presidential Address of Professor A. S. Eddington to the *Physical Society of London* and Published in the *Proceedings of the Society*, January 1932.

atoms which gives rise to 'nuclear matter.'

Hence the above contradiction does not arise.

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SŪTRA 11.

नाणोः ॥११॥

NĀṆOḤ (11)

(नाणोः प्रदेशा भवन्ति ।)

(There are no numerable pradeśas of an indivisible elementary particle of matter.)

An indivisible elementary particle of matter, which is wrongly designated by the word 'atom', always occupies one unit of space. It follows from the definition of space-point (Pradeśa) itself. The author of *Sarvārtha Siddhi* gives the reason. He says:

न हि अणोः अल्पीयान् अन्यः अस्ति ।[198]

There is nothing smaller than an aṇu. It is for this reason that the space occupied by an aṇu is called the Pradeśa or a space-point.

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SŪTRA 12.

लोकाकाशेऽवगाहः ॥१२॥

LOKĀKĀŚEVAGĀHAḤ (12)

(धर्मादीनाम् द्रव्याणाम् लोकाकाशे अवगाहः ।)

(These substances Dharma, Adharma, Jīva, Ajīva, etc., exist only in Lokākāśa.)

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198. *Sarvārtha Siddhi* on Sūtra 11.

धम्माधम्मा कालो पुग्गलजीवा य संति जावदिये ।
आयासे सो लोगो तत्तो परदो अलोगुत्ति ॥[199]

(Lokākāśa is that in which Dharma, Adharma, Kāla, Pudgala and Jīva exist. That which is beyond this is Alokākāśa).

सव्वेसिं जीवाणं सेसाणं तह य पुग्गलाणं च ।
जे देदि विवरमखिलं तं लोए हवदि आयासं ॥[200]

(That which accommodates all matter, the souls and the remaining substances is the Lokākāśa). Also in a Śvetāmbara Sūtra we have :

धम्मो अहम्मो आगासं कालो पुग्गलजन्तवो ।
एस लोगो त्ति पन्नत्तो जिणेहिं वरदंसिहिं ॥[201]

This division of infinite space into Lokākāśa and Alokākāśa, i.e., Universe and Non-universe is based on the Dravyas--Dharma and Adharma. Souls and matter move on and rest up to the confines of the Universe only. Beyond this the media of motion and rest are absent. This determines the limit of the finite universe. The Alokākāśa is an infinite space without any soul or a particle of matter and it surrounds Lokākāśa on all sides.

The following brief description of the Lokākāśa may be given :

The Loka, i.e., the universe is supported in the middle of the Aloka in the form of a human trunk with *siddha śilā* at the top where head should be. The surrounding zones of air in which the universe is floating are said to be three, the inner zone being humid, the middle dense and the outer of rarefied gases. The Siddha Śilā, the abode of Perfected Souls, is the summit of the universe in the form of a bi-meniscus convex lens with its concavity downwards. The universe is divided into three big divisions, the upper world, the middle world, and the lower world. They are situated one above the other and are inhabited by celestial beings, worldly creatures and the hellish beings, respectively.

The total volume of Loka, according to Digambara text is

199. *Dravya-Saṃgraha*, 20.
200. *Pañcāstikāya Sāra*, 97.
201. *Uttarādhyayana Sūtra*, 28.7.

343 cubic Rajjus,[202] and according to Śvetāmbaras 239 cubic Rajjus. One definition of Rajju is given in the footnote on page 82. There is another, quoted by Pt. Mādhavācārya, Research Scholar, in the "*Anekānta*", Vol. 1,3 :

"एक हजार भार का लोहे का गोला इन्द्रलोक से नीचे गिर कर ६ मास में जितनी दूर पहुंचे, उस सम्पूर्ण लम्बाई को एक 'राजू' कहते हैं।"

(Tr.—Rajju is the distance travelled in six months by a ball of iron weighing 1,000 *bhāra* (probably *tolās*; 1,000 *tolās*= 12.5 seers) let fall freely from Indraloka (the abode of heavenly beings).

This definition cannot be subjected to computation since the law of fall of bodies from Indraloka is not known. It appears that in Indraloka the rate of fall depends upon the size of the body and then nobody can say what the uniform acceleration would be. However if we take the Einstein's value of the radius of the finite universe we can arrive at the order of magnitude of a Rajju thus :

Radius of the universe $=1{,}068$ million light-years.

One light-year $=5.88\times10^{12}$ miles

$\therefore$ Volume of a spherical universe, i.e., $(4/3\times22/7\times r^3)$

$$=4/3\times22/7(1068\times10^6\times5.88\times10^{12})^3 \text{ cu. miles}$$

$$=1037\times10^{63} \text{ cu. miles}$$

i.e., 1037 followed by 63 ciphers or 67 digits in all.

Now if $1{,}037\times10^{63}$ be equated to 343 cu. Rajjus, we get: One Rajju $=1.45\times10^{21}$ miles, whereas if equated to 239 cu. Rajjus, we get: One Rajju $=1.63\times10^{21}$ miles, a quantity of the same order of magnitude as before.

Taking the definition of Rajju given on page 82 fn. i.e.

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202. In the standard work on astronomy '*Trilokasāra*' of Nemicandra Siddhānta Cakravarti we read in gāthā 3: सर्वाकाशमनन्तं जगच्छ्रेणिघनप्रमाणो हि, i.e., the cube of Jagatśreṇi is the volume of the Loka and Jagatśreṇi in terms of Rajju is defined in gāthā 7 as जगच्छ्रेणिसप्तमभागो रज्जुः; i.e., 1/7th of Jagatśreṇi is Rajju or Jagatśreṇi is equal to 7 Rajjus. Therefore cube of Jagatśreni is cube of 7 Rajjus. Hence the volume of the Universe is $7\times7\times7=343$ cubic Rajjus.

It should be noted that this gives us another definition of Rajju in terms of Jagatśreṇi but since the latter has been said to be of countless Mahāyojanas it cannot be subjected to a mathematical computation.

Rajju is the distance travelled by a Deva in six months at the rate of 2057152 *yojanas* per *kṣaṇa* we get; since one Mahāyojana =4,000 miles.[203]

2057152 yojanas = 8228608000 miles and 6 months

$= 6 \times 30 \times 24 \times 60 \times 540000$ prativipalānśa[204]

$\therefore$ distance travelled in six months

$= 8228608000 \times 6 \times 30 \times 24 \times 60 \times 540000$ miles

$= 1.15 \times 10^{21}$ miles nearly.[205]

This is almost the same as the magnitude of Rajju arrived at from the Einstein's value of the radius of the universe. If we identify the unit of time (*kṣaṇa*) with Prativipalānśa the agreement is quite close. The following points should, however, be noted in this connection:

The dimentions of the universe have been estimated by Einstein on the basis of a spherical finite universe whereas the shape of the finite universe according to Jaina is anthropomorphous with infinite pure space on all sides.

Considering these odds, it is very difficult to make an exact comparison between the modern determination of the size of the universe and the determination of the ancients. However all that has been said above reflects credit on the work of ancient thinkers.

Modern theories of the universe regard the universe as

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203. There is one element of uncertainty in the definition of *yojana*: the Mahāyojana (used for measuring the dimensions of continents and seas) = 2000 *kośas* but whether one kośa = 2 modern miles of 1760 yards each cannot be said with certainty.

204. 60 Prativipalānśa = 1 Prativipala (प्रतिविपल)

60 Prativipala = 1 Vipala (विपल)

60 Vipala = 1 Pala (पल)

60 Pala = 1 Ghari = 24 minutes (घड़ी)

Therefore 1 minute $= \frac{60 \times 60 \times 60 \times 60}{24} = 540000$ Prativipalānśa.

205. According to Hindu Purāṇas, taking a Yojana equal to 100/11 miles and a *kṣaṇa* equal to $\frac{1}{4}$ of a second, we get the following for the magnitude of a Rajju—

$$2057152 \frac{100}{11} \times 4 \times 15552000$$

(6 months = 15552000 seconds)

On simplification this gives one Rajju

$= 1.16 \times 10^{15}$ miles nearly.

expanding although the final word has not yet been pronounced on this point.[206]

For furthar discussion on Space read pages 33-42 ante.

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SŪTRA 13.

धर्माधर्मयोः कृत्स्ने ॥१३॥

DHARMĀDHARMAYOḤ KṚTSNE (13)

(धर्माधर्मयोः कृत्स्ने लोकाकाशे अवगाहो भवति ।)

(The whole universe or Loka is the place of Dharma and Adharma Dravyas.)

Also :

धम्माधम्मे य दोऽवेए, लोगमित्ता वियाहिया ।[207]

(Tr.—Both Dharma and Adharma are co-extensive with Loka or universe.)

In order to make the point clearer, Ācārya Amṛtacandra gives the following in *Tattvārtha Sāra :*

लोकाकाशे समस्तेऽपि धर्माधर्मास्तिकाययोः ।
तिलेषु तैलवत् प्राहुरवगाहं महर्षयः ॥[208]

Dharma and Adharma are placed in the universe (not like a pot inside a room) but permeate the whole of it as does oil inside the oilseeds.

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206. In *'The Observational Approach to Cosmology'* by Edwin Hubble, an authority on the subject, the author says: "The investigations lead to alternative pictures depending upon the alternative possible interpretations of red shifts." The author further goes on to say whether the 'red shift' in the spectra of the nebulae are due to the expansion of the universe or due to 'some unknown principle of nature' it is not yet decided.

According to Jaina thought expansion of the universe is not possible, as there is no medium of motion outside the Loka. The wellknown red shift has been explained recently from Einstein's theory of Relativity (see the Preface to The New Edition).

207. *Uttarādhyayana Sūtra*, 36.7

208. *Tattvārtha Sāra*, 3.23.

Also in *Sarvārtha Siddhi* :

"अगारेऽवस्थितो घट इति यथा, तथा धर्माधर्मयोर्लोकाकाशेऽवगाहो न भवति । किं तर्हि ? कृत्स्ने, तिलेषु तैलवदिति ।। अन्योन्यप्रदेशप्रवेशव्याघाताभावोऽवगाहनयोगाद्वेदितव्य: ।।"[209]

(Tr.—The Dravyas Dharma and Adharma are not situated in the universe like a pot inside a cabin. Then how? They pervade every iota of it as does oil inside the sesamum seeds. These Dravyas mutually interpenetrate without affecting their respective functions. This is possible because they possess the property of accommodation.)

The diffusion or interpenetrability of Dharma Dravya into Adharma and vice versa is difficult to explain by comparing it with a similar concrete case in Nature for these Dravyas are formless, nonmaterial[210] and non-atomistic, whereas everything concrete in Nature is extremely porous. A similar difficulty is experienced in imagining how an infinite number of souls, who have attained Nirvāṇa, are residing at *siddha śilā*, which is of finite dimensions. This also is explained by saying that pure souls, being non-material, possess the power of inter-penetrability and hence their existence, infinite at one place, is possible. The analogy of light is sometimes employed to explain these cases. The light from a single lamp can fill a whole room as well as light from a thousand different lamps; yet light given by each lamp does not lose its identity but only interpenetrates. However the point cannot be hidden that light is atomic. If we assume these media to have parts, the necessity of assuming the existence of another medium filling the interstices will arise and the original difficulty will now be associated with this new medium and so on. Hence the only reasonable solution is to regard Dharma and Adharma as wholly continuous non-material media mutually interpenetrating like the electrostatic, magnetostatic and gravitational fields, which, although they are of different character do not mix; each preserves its individuality regardless of the other.[211] Many instances may be quoted even in the case of material substances where imagination has to put

209. *Sarvārtha Siddhi* on Sūtra 13.

210. अमूर्तित्वात् त्रयाणां परस्परप्रदेशाविरोध: ।

(*Tattvārtha Vārtika*, 5.13)

211. See *The Evolution of Physics* by Einstein and Infeld, p. 141.

up with apparently glaring contradictions. Imagination is not always the test of possibility.

For instance, the law of gravitation for material bodies as quoted on pages 27-28 ante is that every piece of matter attracts any other piece, but this law does not hold when the distance between the particles becomes very very small. The attraction changes into a repulsion. We quote from a standard book recently published: "Since two different atoms cannot be absolutely superposed on one another, it would seem that a repulsive force must come into play between two atoms when the distance is of the order 10^{-7} cm., and that Newton's law then ceases to hold."[212]

Is this not an apparent contradiction difficult for the mind to grasp? Why should the force of attraction between particles change into a force or repulsion at small distances? Even in ordinary life we see that the repulsive force which keeps the wife away from the husband changes into an attractive force and the wife does not want to be separated from her husband beyond a certain distance.

A similar point has been discussed on page 13 ante, wherein the leading physicist Dr. M. N. Saha, F.R.S., says, "It is not at all clear how stripped atoms with a large excess of positive electricity can be so closely packed; because as the charges are of the same sign, the tendency would be for infinite dispersion instead of abnormal condensation. But such cases of abnormal condensation are not altogether unknown in physics."

Hale in 1918 demonstrated beyond doubt that the sun-spots had an intense magnetic field of about 50,000 gauss, which is further confirmed by the phenomenon of Zeeman effect. But this is quite unbelievable in the light of the experiments carried on the surface of the earth. The temperature of the sun-spots is very very high and experiments show that a white hot body cannot retain magnetism. In spite of this it exists in the body of the sun.

The antithesis between a wave and a particle is the burning problem of the day. Certain phenomena in physics are explained by saying that light energy consists of waves in æther and in certain others we have to postulate that light consists of a shower of bullets shot from the luminous body. How can these two

212. *Properties of Matter* by Champion and Davy. (1936).

contradictory aspects be reconciled? As Sir William Bragg has said "On Mondays, Wednesdays and Fridays we adopt the one hypothesis; on Tuesdays, Thursdays and Saturdays the other." This is a good piece of humour rather than an explanation. The contradiction becomes all the more conspicuous when we say that experiments have been discovered in which both ideas are found necessary *at the same time*, for instance in the case of counting the interference fringes by means of an electron-counter.

It is difficult to reconcile such cases of Pudgala Dravya what to say of the formless realities whose laws of interaction cannot be studied by experiments.

The young English physicist Dirac introduced at one time the apparently funny conception of the electron of 'negative mass'—the electron which "does not in any way betray its existence by any measurements whatsoever,—which has played its role on the stage of the universe and retired for good."

These examples suffice to show that however hard it may be for the imagination to deal with the interpenetrability of Dharma and Adharma Dravyas, it is nevertheless the legitimate explanation of things.

Now coming to the next point, viz., the existence of these substances (media) within the confines of the Loka and not beyond, we find that this is a much more reasonable and satisfactory assumption than Einstein's finite universe 'with no space beyond a certain space'. According to Einstein's Cylinder theory neither the universe had a beginning nor will it ever come to an end. In other words, it is a stable unit. If we regard our universe as infinite it cannot be stable at the same time, for in that case we can think the infinite space to be filled with a number of universes and their attractions on our universe would scatter it into infinite space. In order, therefore, to maintain the stability of our universe running from an infinite past into an infinite future the universe was conceived as of finite dimensions, but since mathematical conditions negative the idea of a void beyond finite universe, the whole space was taken to constitute the finite universe.

The Jaina concept is more comprehensive because the stability of the universe is maintained by saying that there are no media of motion and rest beyond a certain limit and consequently

matter or energy can never go out of it, i.e., the total energy of the universe will ever remain constant. Further, since Jainism regards space as a reality, there is no void beyond Loka but only one substance,—pure space and nothing else. All the difficulties are thus ingeniously overcome.

Dr. Phylip Norrison of Massachussetts Institute of Technology (USA) recently declared "Astronomers know far too little to make a choice among theories of the universe and no theory is adequate at the moment." Still the astronomers of the world are divided into two groups on the question of the origin of the universe. One group believes in the Big Bang theory and the other group in the continuous Creation theory, also known as Steady State theory. According to the Big Bang theory some ten billion years ago, the universe began explosively as a fireball of matter and radiation expanding from almost a point (not out of nothingness) the Primeval Egg and is still expanding.

The Steady State theory was first advanced by British Scientists Hermann Bondi and Thomas Gold in 1948. Later, British Astrophysicist Fred Hoyle joined hands with this group to become one of the great advocates of Steady State Cosmology. According to this theory the universe was not created at any instant of time but the universe exhibits the same large scale appearance from eternity to eternity.

This is in perfect agreement with the Jaina view.

SŪTRA 14.

एकप्रदेशादिषु भाज्यः पुद्गलानाम् ॥१४॥

EKAPRADEŚĀDIṢU BHĀJYAḤ PUDGALĀNĀṀ (14)

(लोकाकाशे एकप्रदेशादिषु भाज्य एकप्रदेशसंख्येयासंख्येयानन्त-प्रदेशानां पुद्गलानामवगाहः ।)

(*Tr.*—In one Pradeśa, i.e., in one unitary cell of space only one atom of matter will find place if it is in a free state but in

an aggregate form any number of atoms can occupy one or more cells of space.)

The same idea is expressed in *Dravya Saṃgraha*:

एयपदेसो वि अणू णाणाखंधप्पदेसदो होदि ॥[213]

(An atom of matter, though occupying one cell of space, may occupy many cells when it combines with other atoms to form different Skandhas (aggregates). From this point of view it may be looked upon as multicellular (Bahupradeśī).

The author of Sarvārtha Siddhi has explained this phenomenon, in greater detail, thus:

एकस्मिन्नाकाशप्रदेशे परमाणोरवगाहः। द्वयोरेकत्रोभयत्र च बद्धयोरबद्धयोश्च। त्रयाणामप्येकत्र द्वयोस्त्रिषु च बद्धानामबद्धानां च। एवं संख्येयासंख्येयानन्तप्रदेशानां स्कन्धानामेकसंख्येयासंख्येय-प्रदेशेषु लोकाकाशेऽवस्थानं प्रत्येतव्यम्। ननु युक्तं तावदमूर्त्तयोर्धर्माधर्मयोरेकत्राविरोधेनावरोध इति। मूर्तिमतां पुद्गलानां कथमित्यत्रोच्यते—अवगाहनस्वभावत्वात्सूक्ष्मपरिणामाच्च मूर्तिमतामप्यवगाहो न विरुद्ध्यते। एकापवरकेऽनेकदीपप्रकाशावस्थानवत् ॥[214]

(One atom occupies one cell of space or two atoms in a state of abnormal condensation may be accommodated in the same cell. Two free atoms will occupy two cells as well as two atoms forming a diatomic molecule will cover two cells. Three atoms can be located in a single cell if they are all in a state of abnormal condensation,[215] they can occupy two cells if two atoms are in a state of condensation and one is free; they occupy three cells if they are all free. And this process is to be continued to infinity.)

Then the question has been raised as to how such an enormous crowding of material atoms is possible, although interpenetrability may be true in the case of non-material media like Dharma and Adharma. The answer given is that these are

213. *Dravya Saṃgraha*, 26.

214. *Sarvārtha Siddhi* on Sūtra 14.

215. For an explanation of 'abnormal condensation,' i.e. Sūkṣma Avagāhana Śakti read pages 3-14 ante.

cases of abnormal condensation like the superposition of lights from different lamps in a single room.

The same reason has been assigned for this crowding by other writers. For instance:

"अधिकरणविरोधादानन्त्याभाव इति चेन्न, सूक्ष्मपरिणामाव-
गाहनसामर्थ्यात् ॥"[216]

Or

"अवगाहनसामर्थ्यात् सूक्ष्मत्वपरिणामिनः ।
तिष्ठन्त्येकप्रदेशेऽपि बहवोऽपि हि पुद्गलाः ॥"[217]

This distribution of atoms in pradeśas or cells of space has a very great likening to the distribution of particles in Bose-Einstein or Fermi-Dirac Statistics where probabilities of various combinations have been mathematically calculated. We can only make a passing mention of this highly complex piece of mathematics.

In the standard work '*A Treatise on Heat*' by Dr. M. N. Saha, F.R.S. and B. N. Srivastava, the calculation of probability from Bose-Einstein Statistics is given on p. 717. "The next operation is to distribute these N_s-particles amongst A_s-cells so that each cell may contain 0,1,2......up to N_s identical particles." Then follows the expression for the probability of the various states.

Also on page 718 "In the Bose-Einstein Statistics a particular cell or degree of freedom was supposed to be capable of accommodating any number of particles. Fermi conceives a third kind of statistics in which one cell should not accommodate more than one particle."

How an infinite number of atoms in a subtle (Sūkṣma) state can be accommodated in one cell has been discussed in pages 13-14 ante.

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216. *Tattvārtha Rājavārtika* on Sūtra 5.10.
217. *Tattvārtha Sāra*, 3.26.

SŪTRA 15.

असंख्येयभागादिषु जीवानाम् ॥१५॥

ASANKHYEYABHĀGĀDIṢU JĪVĀNĀṂ (*15*)

(लोकाकाशे असंख्येयभागादिषु जीवानामवगाहो भवति ।)

(Souls are existent in every iota of space beginning with one or more countless fractions of it up to the whole universe, i.e., if the space is divided into countless parts, the size of a soul can be so small as to occupy one or more of these parts and in special cases the size of a single soul can fill the whole universe.)

अणुगुरुदेहपमाणो उवसंहारप्पसप्पदो चेदा ।[218]

(Jīva becomes equal in extent to a small or a large body by contraction and expansion.)

This view of the Jainas has been badly criticized by Śankarācārya in his commentary on Vedānta-Sūtra 2·2·34. He argues that if a soul is equal in extent to its body, it is impossible that the same soul can enter into the bodies of a fly and an elephant. In fact there is a controversy amongst the philosophers regarding the precise part of the body which should be assigned as the seat of the soul. Some think it is located in the heart, others think it is located in the head or in some specific brain centres. If this view is accepted it is difficult to think how one could feel the bodily affections as its own. Since a body grows from a microscopical size in the mother's womb to its full proportions and contracts again, at the end of its earthly career, to reincarnate into a new seed, it follows that the size of the soul cannot remain fixed.

This subject is well discussed by S. J. Maher in his work on Psychology where he says : "(the soul is) an immaterial energy exerting its proper activities ubiquitously throughout the living body."

According to the Jaina view the soul expands to fill the whole universe at the time of Samudghāta[219] (i.e., exit of the soul from

218. *Dravya Saṃgraha*, 10.

219. "मूलसरीरमछंडिय उत्तरदेहस्स जीवपिंडस्स ।
णिग्गमणं देहादो हवदि समुग्घादणामं तु ।

(*Gommata-Sāra*, Jīvakāṇḍa, 668).

the body without leaving the original body altogether).

Science associates life[220] with tiny organisms called cells which are composed of a substance named 'protoplasm'. According to Arthur Dendy, D.Sc., protoplasm "is a mixture of proteids, mineral salts and water, which has remarkable powers of selection, e.g., one organism will select silica while another selects calcium carbonate from the same sample of sea-water and for the same purpose."[221]

It is evident that 'life' must be associated with protoplasm since non-living combination of matter cannot be thought of as possessing the power of selection referred to above.

"Protoplasm is the name for the viscous fluid which contains the life of every cell."[222]

"This tiny cell has powers and complexities that put it in the class of a higher animal. You cannot hope to account for its substance[223] until you are able to melt down a whole animal and account for its emotions by rows of O and H and C and some numerals.[224] The ultimate analysis of a cell must be as difficult as the analysis of a robin. When you give a common name, protoplasm, to the substance that you find in all cells you are not saying anything."[225]

Dr. John Baker gives us, the following information :

"Quite recently a most ingenious apparatus has been inven-

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220. "Protoplasm, the fundamental constituent of both plants and animals, contains chemical compounds......chief amongst these are the proteids. It is the presence of these unstable proteids which confers upon protoplasm its peculiar fitness to form which has been so aptly termed by Huxley "as the physical basis of life."

(Vide *Outlines of Evolutionary Biology*, p. 7)

"Whatever view we may take with regard to the question of vitalism, there can be no doubt that the most distinctive property of living protoplasm is its power of controlling chemical and physical processes so as to make them yield results different from those which would be obtained if we were dealing with not-living matter. The various processes upon which depend the functions of movement, nutrition, respiration and excretion all appear to be controlled in this manner......" (Ibid., p. 23.)

221. Ibid.

222. *Exploring The Universe* by H. Ward, p. 145.

223. The substance is the life, the soul. —(The author.)

224. It refers to a chemical formula in terms of oxygen, hydrogen and carbon.

225. *Exploring The Universe* by H. Ward, p. 146.

ted, by means of which we can poke an extremely fine glass needle into a single living cell and watch what happens under the microscope.... This is an extraordinary achievement. Another most striking line of research is to take a few cells out of a living body and keep them alive in a little glass compartment.... It is astonishing how long they live if you are very careful to seal them into their glass compartment without letting any germs get in. These studies of living cells are going to form a very important branch of the science of life."[226]

Since all living bodies are composed of cells, beginning from that of amœba (a unicellular organism), which propagates its progeny by fission of its body, to highly complex organisms like that of a man whose body is composed of trillions of such cells, it follows that life and hence soul must permeate every living cell, i.e., soul is co-extensive with the body. The experiments of Sir J. C. Bose, F.R.S., on the response of plants[227] under chemical or electrical stimulus point in the same direction, i.e., diffusion of the soul in the entire body of the plant. (Read also pages 56 onwards.)

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SŪTRA 16.

प्रदेशसंहारविसर्पाभ्यां प्रदीपवत् ॥१६॥

PRADEŚASAṂHĀRAVISARPĀBHYĀṂ PRADĪPAVAT (16)

(प्रदेशसंहारविसर्पाभ्यां प्रदीपवत् लोकाकाशे असंख्येयभागादिषु जीवानामवगाहो भवति ।)

(Tr.—By the contraction and expansion of the pradeśas, the soul, although it has a countless number of pradeśas, occupies space like the light from a lamp. It can occupy the smallest possible body, viz., that of a bacterium or the biggest body of a Mahāmaccha, with a length of 1,000 yojanas.)

According to Jainas, therefore, a soul, although devoid of

226. *An Outline for Boys and Girls and their Parents*, p. 187.

227. The faculty of receiving and responding to stimuli of various kinds is one of the most characteristic features of living protoplasm.

—(*Arthur Dendy*, p. 215.)

parts, is capable of expansion and contraction, like the light from a lamp and can become co-extensive with the universe under special circumstances. Seven kinds of *samudghāta* are recognized in Jain philosophy :

vedanā samudghāta—Extension of the soul outside the body through excessive pain in search of the proper herb which would heal up the pain. When the pradeśas of the soul come in contact with the required herb, the pain disappears and then the pradeśas contract and the soul occupies the normal position inside the body.

kaṣāya-Samudghāta—Extension of the soul outside the body through excessive anger in order to cause injury to the source of provocation.

vikriyā-Samudghāta—The potentiality of the soul by virtue of which it can extend or diminish the size of the body enormously or can form a number of living bodies by extension of the pradeśas. For instance it is said in Hindu *Rāmāyaṇa* that Hanumān ; going in search of Sītā, visited *aśoka vāṭikā*, in the diminutive form of a fly or it is reported that the great Yogi Lord Shri Kriṣṇa used to dance with Gopis, each Gopi with one Kriṣṇa to pair.

maraṇāntika-samudghāta—The extension of the soul, just before death, to the place where it is going to be re-born and the subsequent restitution after the visit.

taijas-samudghāta—is of two sorts, Śubha, and Aśubha. In the first kind, we have the exit of a white form, twelve yojanas in length, nine yojanas broad from the right shoulder of a sage through extreme commiseration when famine or epidemic spreads in some part of the country. After destroying the calamity the figure re-enters the body. In the latter kind, a red figure of similar dimensions issues forth from the left shoulder during excessive rage, and after wreaking vengeance destroys the sage himself.

āhāraka samudghāta—The exit of a white human figure, one cubit in length, from the forehead of a sage to resolve a doubt by seeing some Kevali (a saint—possessed of infinite knowledge).

kevalī-samudghāta[228]—Under some special circumstance the soul of an Arhant (Pure-Soul Incarnate) expands and fills up

228. For details of various kinds of Samudghāta read *Gommaṭa Sāra*, Jīvakāṇḍa, gāthās 543-667-669, S.B.J., Vol. V.

the whole universe without leaving the original body.

All systems of Indian philosophy regard soul as potentially divine and the seven forms of *samudghāta* described above give an idea of the latent capacities of the soul, but one thing which human mind fails to grasp is "how can a substance without parts expand and contract like this ?"

The great mathematician Professor Max Born, in his work "*The Restless Universe*" has told a fairy tale on page 240 in which a gnome presents a boy with a money-box in the form of an earthen ware-ball hermetically closed on all sides. The boy moves about, shaking the ball all the time and at random moments a gold piece jumps out of the solid ball, although there is not even a trace of hole in it.

Prof. Max Born adds the following in conclusion : "For what we have just described as happening in a fairy tale, *pieces of solid matter moving through solid walls does actually happen* when nucleii emit alpha-particles." It is worthy of notice that even in this highly rationalistic age of Science such apparent absurdities find a passport. The reason is that the facts cannot be overlooked, whether we are able or not able to offer 'a rational explanation' for them. For instance, in the issue of "*Armchair Science*" (London) for December 1937 we read of 'men who see without eyes.' After describing the case of Ouvrieu, the writer says, "There is not the least doubt of the facts of this case, as they are supported by the testimony of noted specialists..." and adds that "these phenomenal powers are indeed seldom capable of rational explanation." Next he quotes the case of the famous clairvoyant Kele, who has during the last seven years detected several cases of would-be suicides and premeditated murders. "He possesses an inexplicable faculty for knowledge and psychiatrists, while compelled on the evidence to accept the facts, are totally at a loss to offer any convincing explanation." Many such instances can be multiplied. However in the present case there is one ocular evidence.

The protoplasm, with which biologists associate the phenomena of life, possesses a remarkable property of *contraction* under stimulus electrical or otherwise. It can be easily seen with the eyes as demonstrated in the famous experiments of Sir J. C. Bose, F.R.S. Contraction of protoplasm means contraction of living substance, the soul, showing thereby that the

hypothesis of the expansion and contraction of the soul substance is tenable.

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SŪTRA 17.

गतिस्थित्युपग्रहौ धर्माधर्म-योरुपकारः ॥१७॥

GATISTHITYUPAGRAHOU DHARMĀ-DHARMAYORUPAKĀRAḤ. (17)

(जीवानाम् पुद्गलानाम् च गतिस्थित्युपग्रहौ धर्माधर्मयोरुपकारो भवति।)

(Tr.—The function of Dharma and Adharma is to support respectively the motion and rest of souls and matter.)

These Dravyas and their nature have been fully discussed. in pages 14-33 ante. We shall deal here with a few points more:

The author of *Sarvārtha-siddhi* has raised various interesting questions and then answered them satisfactorily. What is the harm if we associate the functions of motion and rest with the space which exists everywhere ? The answer is :

"एकस्यानेकप्रयोजनकल्पनायां लोकालोकविभागाभाव:"

i.e. "By doing so, the division between Loka and Aloka, finite universe and infinite empty space surrounding it, would disappear."

As has been discussed in pages 96 *et. seq.* this division is absolutely essential in order to ensure the stability and eternity of the universe.

The next question raised and answered by him is

"तुल्यबलवत्त्वात्तयोर्गतिस्थितिप्रतिबन्ध इति चेन्न, अप्रेरकत्वात्"

i.e. "How can motion or rest be possible when the Dravyas Dharma and Adharma are uniformly distributed in the universe and have equal potency? i.e., the motion of bodies would be opposed by the co-existing and co-operative forces of Adharma and *vice versa.*" And the answer given is: "It is not so because

Dharma and Adharma are not active forces but passive media." The same idea in *Rājavārtika* is expressed as follows :

"उभयानुग्रहात्परस्परप्रतिबन्ध इति चेन्न, स्वतः परिणामसामर्थ्यं-
स्यानुग्रहाकांक्षित्वात् कुण्टनयनयष्टिप्रदीपवत्" ॥

Just as a lame possesses the power of walking or an eye possesses the power of seeing, but the former requires the aid of a crutch or the latter needs light in order to see, so does the motion and rest of bodies need the help of the invisible media, Dharma and Adharma.

We have shown in the commentary on Sūtra 1 that the Aether of the scientists is the inactive medium, corresponding to Dharma Dravya, which helps in the motion of things, while Adharma is another invisible medium, called the Field, through which the forces of gravitation and electro-magnetism operate and maintain the stability of the microscopic as well as of the macroscopic world. The phenomenon of gravitation, as explained by Einstein is a passive property, wrongly associated with Space. (see page 31 ante) We give below a few more quotations to show that the scientists do recognize a separate medium for the 'rest' of the bodies.

"The gravitational constant is independent of the nature of masses. The same researches proved that the gravitational constant is independent of the state of chemical combination of the elements in the masses. The fact that an element is radioactive has also been shown to have no effect on the gravitational constant. Eotvois and his collaborators and also Majorana, Austin and Thwing have investigated the effect of interposing layers of different media between attracting and attracted bodies. Very dense media, such as lead and mercury, were used. No effect could be detected."[229]

The gravitational constant represents the action of the medium on the phenomenon of gravitation and since the medium is non-material, invisible, and passive we see that its properties do not change whether we bring mercury or lead between attracting bodies or bring out any physical or chemical change in the surrounding things.

229. *Properties of Matter by* Champion and Davy *p. 43.*

"Gravitation[230] is linked up with light and *other Electro-magnetic-phenomena*."[231]

This statement amounts to saying that the cause of 'rest' of the electrons inside an atom, or that of atoms inside a molecule is the same as that which keeps the members of the solar system together. More recently N. R. Sen has shown that Einstein's modified field equations have the consequence that an electron of finite radius must have ¾ of its total energy of electro-magnetic origin and ¼ of gravitational origin (*Zet. F. Physik*, 40). This leaves no doubt that the reality, which Jain philosophers have given the name Adharma, is responsible for the stability of the atoms and the molecules as also of the galaxies and the solar system. This Adharma Dravya is being called under the name of 'field of gravitation' and the 'electro-magnetic field' which for want of clear conception is vaguely associated with the surrounding space. So that we read:

"All matter or energy modifies the properties of Space-Time in its neighbourhood, producing what is called a field of gravitation......It is not a direct instantaneous action at a distance produced by an attracting body. The cause of the deformation of space-time in the neighbourhood of matter or energy,[232] that is, the cause of gravitation, is still unknown."

Since 'science' means 'measurement' and Invisibles are not always susceptible to measurement, the scientists cannot posit any invisible entity unless the postulate is extremely essential for explaining phenomena in Nature. Many such invisible quantities do exist with the scientists, whose nature they are ever trying to explore. For instance, they have lately postulated the existence of an unknown particle 'neutrino' to save the law of conservation of matter and energy[233] breaking down. So we read in the "*Reports on the Progress of Physics*," Vol. III (1937, London), p. 95: "Attempts to detect and ionization by the

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230. Gravitation is said to be the cause of stability of the macroscopic world, the galaxies or the solar system while electro-magnetic forces account for the binding of atoms within a molecule. According to the Jains both these functions are discharged by the same Dravya, Adharma. This view is confirmed here.

231. *Properties of Matter* by Champion and Davy, p. 45.

232. Ibid.

233. The law is : Matter or energy can change form but they are indestructible.

neutrino have failed,[234] and the *only evidence for its reality is in its success in accounting for the facts of beta-ray disintegration.*"

Shri Pūjyapāda in Sarvārthasiddhi himself has raised the question :

"अनुपलब्धेर्न तौ स्तः खरविषाणवदिति चेत् न । सर्वज्ञेन निरतिशय-प्रत्यक्षज्ञानचक्षुषा धर्मादयः सर्वे उपलभ्यन्ते ।"

Are not the Dharma and Adharma Dravyas like the horns of a donkey, when they are not visible with the eyes? He answers, No. The Omniscient eyes of the 'Universal Observer' have seen these Dravyas which is the ancient way of saying that these realities are absolutely necessary in order to explain the processes in the universe.

We are, therefore, of opinion that if instead of vaguely talking about 'field of electro-magnetism and gravitation'[235] We postulate in clear terms a separate medium of rest, like the æther, many difficulties would disappear.

Science is at present fumbling over the question of Adharma Dravya. As we have mentioned on p, 43 f.n. the nearest approach to this concept is the Field of the Physicists. But they are again trying to associate material properties with this immaterial medium, the exact nature of it being still a matter of controversy. We quote here a few lines from the *Evolution of Physics* by Einstein and Infeld, p. 256 :

"We have two realities; *Matter and field.* There is no doubt that we cannot at present imagine the whole of physics built upon the concept of matter. But what are the physical criteria distinguishing matter and field?...We could say, Matter is where the concentration of energy is great, field where the concentration of energy is small.

But if this is the case, then the difference between matter and field is a quantitative one. There is then no sense in regarding

234. In recent years the neutrino has been discussed and confirmed.

235. In the report published in the '*Hindustan Times*' of 31st August 1938, of a paper read by Sir Sulaiman before the *National Acadamy of Sciences, India*, at Allahabad, on 28th August, it is said that "Sir Shah Sulaiman has developed his theory further, claiming to have identified gravitation with electricity". If so, the Jain view of Adharma Dravya finds full confirmation.

matter and field as two qualities quite different from each other. It seems impossible to give an obvious qualitative criterion for distinguishing between matter and field....Could we not reject the concept of matter and build a pure field physics?...We have not so far succeeded in fulfilling this programme convincingly and consistently. At present we must still assume in all our theoretical constructions two realities: field and matter.

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SŪTRA 18.

आकाशस्यावगाहः ॥१८॥

ĀKĀŚASYĀVAGĀHAḤ (18)

(जीवानामजीवानाम् च आकाशस्य उपकारः अवगाहः ।)

(The function of Space, i.e., Ākāśa is to give place to all other substances.)

The nature of Ākāśa has been an intriguing problem for long. The Idealistic school of philosophy in the East as well as in the West has regarded it merely as a 'form of conception.' Kant, the great European philosopher of this school, regarded the external objective world including 'the starry heavens above' as a fictitious creation of the human mind. Nature or Prakṛti, according to him, arises out of the co-operation of sense-materials and the activity of mind. Space and time form the a *priori* constitutive elements of experience.

The metaphysical dualism of Kant was converted into idealistic monism by the German philosopher Hegel. He reduced all finite things and persons as mere attributes of a certain Absolute of the nature of a spirit. Herbert Spencer, in his own way, strengthened the arguments in favour of monism and phenomenality of experience. The European scholars like Max Muller and Deussen were influenced by the same ideas. In the East the Vedānta school advocates the uncompromising theme of monism (Advaitavāda) and has no explanation to offer for time, space and the Laws of Causality which constitute the world of matter and energy.

The times have changed now. The Hegelian doctrine, as

sponsored today by Bradley and Bosanquet, which identifies thought with Reality, is openly 'condemned as pernicious metaphysics.' This is due to the introduction of modern scientific methods in the pursuit of knowledge. The Idealistic school regarded Nature as a form of conception, the new school of Realism regards 'concept as a convenient fiction to comprehend Nature'.

"The mathematical discoveries of Cantor, Peano and Frege have once for all reclaimed certain fundamental mathematical notions such as the concepts of infinity and continuity from the unwarranted criticisms of metaphysicians. As Mr. B. Russell clearly points out, modern Idealism must once for all relinquish its Kantian basis. It can no more depend upon the so-called demonstration offered by Kant as to the impossibility of real space and time.

The wave of Realism is further intensified by the fact that it is intimately associated with modern science. The traditional Hagelian idealism of the West has been peculiarly adverse to the interest of science. It may be safely asserted that a system of metaphysics which does not take into consideration the method and achievement of modern science is so far self-condemned... ...The Jain system of thought is peculiarly consistent with modern Realism and modern science......"[236]

The representative school of Hindu Realism, viz., the Vaiśeiṣka philosophy, no doubt, regards Ākāśa as one of the nine realities constituting the universe but the properties associated with it are more those of Aether rather than that of mathematical space. (see pages 70-71 ante).

"The reality of space is also borne out by the fact that in order to reach things it is necessary to traverse the distance which separates them from ourselves. Further the removal of space can only result either in the throwing of all things into 'nowhere', or in the complete isolation of each individual atom from all the rest of its kind, and into being doomed to an eternal solitary confinement. The one is, however, as inconceivable as the other, for 'nowhere' is as great an absurdity as absolute vacuity and isolation is only possible in space, never

236. *Philosophical Introduction to Pañcāstikāya Sāra* by Prof. A. Chakravarti, S.B.J. Series, Vol. III, p. XIX.

in spacelessness."[237]

The great astronomer Prof. A. S. Eddington is right when he says: "We must rid our minds of the idea that the word space in science has anything to do with void. As previously explained it has the other meaning of distance, volume, etc., quantities expressing physical measurement...In any case the physicist does not conceive of space as void. Where it is empty of all else there is still the æther."

The slight misconception expressed in the last sentence, viz., where it is empty of all else there is still the æther, has arisen out of the fact that although scientists have come to regard space as a reality and associate all necessary qualities with it and more but they have failed to regard it as a substance in itself. If the latter point is accepted it is quite easy to see the truth of the Jain view that beyond finite universe there is infinite extension of the space substance. If space where finite, 'it would be limited by something else and would have a beyond to it which must be either another piece of space or pure emptiness.' Since the latter is an impossibility, it must be the former and therefore space must be a real substance, *'for pure expansion is not thinkable in the absence of a substance in which it might inhere'*.

Consequently the claim of space to rank amongst one of the fundamental substances constituting the universe is firmly established.

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SŪTRA 19.

शरीरवाङ्मनःप्राणापानाः पुद्गलानाम् ॥१९॥

ŚARĪRA-VAṄMANAḤ-PRĀṆĀPĀNĀḤ PUDGALĀNĀM. (19)

(शरीर-वाङ्-मनस्-प्राण-अपानाः जीवानाम् पुद्गलानाम् उपकारः ।)

(Matter forms the physical basis of the bodies, speach, mind

237. *Key of Knowledge*, p. 747-48.

the respiration of the souls.)

In *Gommata Sāra*, the brilliant composition of Śri Nemicandra Siddhānta cakravarti, we read the following :—

पुग्गलाणि पुणो ।
देहादीणिव्वत्तणकारणभूदा हु णियमेण ॥
आहारवग्गणादो तिण्णि सरीराणि होंति उस्सासो ।
णिस्सासोवि य तेजोवग्गणखंधादु तेजंगं ॥
भासमणवग्गणादो कमेण भासा मणं च कम्मादो ।
अट्ठविहकम्मदव्वं होदित्ति जिणेहिं णिद्दिट्ठं ॥[238]

(Tr.—Matter is the cause of making of the bodies. One kind of molecules, called Āhārakavarganā, form the first three types of bodies described on page 64 ante and the respiration. Electrical energy (Tejo-varganā[239]) forms the fourth type, viz., the electrical body.)

Speech and mind (mana) are constituted by another two specialized forms of matter-molecules called respectively Bhaśā-varganā and Mano-varganā. The inner subtle body (kārmana śarira) which is the seed of all mental and physical activities is made of eight kinds of Kārmic matter.

The fifth class (Sūkśma) out of the six sub-classes of matter (vide page 65 ante) has been further divided into five divisions called varganās : *āhāra varganā, taijasa varganā Bhāśā varganā, mano-varganā kārmānā varganā.* This is a case of specialization of fine 'matter'. A similar specialization has been found to exist in the case of protoplasmic cells of living matter. For instance, the great biologist, Arthur Dendy writes as follows :

"There is another point of view with regard to the living cell. It is not only the morphological or structural unit of the body but also the physiological or functional unit"[240].

Human body has been estimated to contain 26 trillion cells but divided into groups, each group has a special function to perform. The group of cells, which constitutes the eye, cannot

238. *Gommata Sāra* Jīvakānda, 606-608.

239. It should be noted here that Jainism regards electrical as atomic and so it is.

240. *Outlines of Evolutionary Biology* (Arthur Dendy), p. 68.

discharge the function of the auricular group and this differentiation cannot be explained unless we assume that matter constituting the various groups of cells is differentiated in some way.

Matter supports the process of respiration is clear from the following :

"Respiration, in the scientific acceptance of the term, is simply the exchange by the organism of the carbon-di-oxide gas which has been formed in the body in the process of combustion for the oxygen gas which is required for that combustion. It is therefore a double function—oxygen being taken in and carbon-di-oxide got rid of by one and the same process.''[241]

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SŪTRA 20.

सुख-दुःखजीवितमरणोपग्रहाश्च ॥२०॥

SUKHA-DUḤKHA-JĪVITA-MARAṆOPAGRAHĀŚCA. (20)

(जीवानाम् सुख-दुःख-जीवित-मरण-उपग्रहाश्च पुद्गलाना-मुपकारो भवति ।)

(Soul experiences pain, pleasure, life and death through the agency of matter.)

Shri Kundakundācārya says :

"कत्ता भोत्ता आदा पोग्गलकम्मस्स होदि ववहारो ॥"[242]

(From the practical point of view, a worldly soul draws in the fine kārmic matter in consequence of the activities of mind, body and speech and experiences their results.)

The theory of transmigration of soul has been explained by Jains in terms of karmic matter, extraordinary conception found in no other system of thought. According to this view, all actions of embodied living-beings, whether mental or physical, including speech, are followed by an influx of fine molecules of energy towards the soul, the latter constituting what is called

241. Ibid. p. 8.
242. *Niyama-Sāra*, 18.

the *Kārmaṇa Śarīra.* (vide page 64 ante) Activity of a good kind attracts meritorious while activity of a bad kind attracts the opposite kind of karmic matter, The *Kārmaṇa Śarīra* is the vehicle of transmigration and passes from life to life. The dragging of the soul from one physical body to another is well described by late Mr. J. L. Jaini.[243]

"It is not fate, nor even predestination : but it is the ever-continuous balancing of the different accounts that we keep with the forces of life. There can be no mistake, no suppression and no evasion. The credit and debit sides go on automatically ; and whatever is due to us is paid us ungrudgingly and without demand. The continuity cannot be broken by change of house ; the debits of London are not extinguished by going to Berlin : nor is the liquidation suspended till the Day of Judgement. The karmas are not extinguished simply because we give up the body called A. When we are dead as A, the karmas must still bear full fruits. The karmas constitute the Karmic body and it drags us into another state of being."

The fusion of soul with matter results in the production of eight kinds of forces : those which obstruct knowledge ; those which interfere with perception ; those which obstruct right beliefs ; those that regulate the experiences of pleasure and pain ; those which are responsible for the building of different kinds of bodies and shaping the limbs ; those that determine the duration of life ; those that determine the lineage of the individual and lastly those which interfere with the doing of desired actions.[244]

The union of karmic matter with soul lasts for a limited time according to the intensity of passion present at the time of the influx. During this time it produces its effects and then sheds off gradually just as food and medicine produce effects inside the body for some time and then go out. Control of mind, body and speech leads to the prevention of Karmic matter coming in and total freedom from all Karmic matter raises the soul to the status of divinity.

The theory outlined in the previous paragraph seems to be confirmed by the picture of life in which the activities of mind

243. *Outlines of Jainism*, p. 29.

244. For a fuller and detailed account of these forces, read *Gommata Sāra*, Karma Kāṇḍa, S.B.J. Series, Vol. VI.

and matter constitute a super-radio sending and receiving a continuous chain of electrical waves, an account of which is given on page 71 et seq. Influx of these waves is nothing but the influx of fine Karmic matter.

Not only is matter the basis of pleasure, pain, life and death but one piece of matter is capable of producing physical and chemical changes in another piece of matter. This fact is connoted by the word *upagraha* in the Sūtra. Says the author of *sarvārtha-siddhi* :

"स्वोपग्रहप्रदर्शनार्थमिदम् । पुद्गलानां पुद्गलकृत उपकार इति ।। तद्यथा—कांस्यादीनां भस्मादिभिर्जलादीनां कतकादिभिरयःप्रभृतीना-मुदकादिभिरुपकारः क्रियते ।।"[245]

The examples given here are the purification of bronze by the addition of certain ashes, the purification of water by the addition of an organic substance Nirmali and tempering of steel with the help of water.

No more examples need be multiplied in this connection as it is well-known that the whole super-structure of modern science is built upon physical and chemical changes in matter.

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SŪTRA 21.

परस्परोपग्रहो जीवानाम् ।।२१।।

PARASPAROPAGRAHO JIVĀNĀM. (21)

(परस्परोपग्रहो (जीवानाम्) जीवानाम् (उपकारः) भवति ।)

(The mundane souls help and support each other.)

The author of Sarvārtha Siddhi amplifies this Sūtra as follows :

"स्वामी भृत्यः, आचार्यः शिष्यः, इत्येवमादिभावेन वृत्तिः परस्परोपग्रहः ।। स्वामी तावद्वित्तत्यागादिना भृत्यानामुपकारे वर्तते । भृत्याश्च हितप्रतिपादनेनाहितप्रतिषेधेन च ।। आचार्य उभयलोकफल-

245. *Sarvārtha Siddhi* on Sūtra 5·20.

प्रदोपदेशदर्शनेन तदुपदेशविहितक्रियानुष्ठापनेन च शिष्याणामनुग्रहे वर्तंते । शिष्या अपि तदानुकूल्यप्रवृत्या आचार्याणामुपकाराधिकारे...।"

(The master and his servant, the teacher and the taught are examples of mutual obligation. The master helps the servant with money and the servant repays through his humble service ; a teachers renders a great service through his sound training and advice while the pupil repays the same through his good conduct.)

The meaning of this Sūtra is too obvious and needs no elaborate commentary. We all depend upon one another. The peasant provides corn to humanity, the weavers the clothes and so on. Not only that, we very often are the cause of pleasure and pain to others and sometimes responsible for their lives and deaths.

This Sūtra has a great ethical value ; it enjoins all worldly beings as a duty to live in co-operation and harmony, doing no harm to anybody so that eternal peace may reign on earth.

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SŪTRA 22.

वर्तनापरिणामक्रियाः परत्वापरत्वे च कालस्य ॥२२॥

VARTANĀ-PARIṆĀMA-KRIYĀḤ PARATVĀPARATVE CA KĀLASYA. (22)

(वर्तना-परिणाम-क्रियाः परत्वापरत्वे च जीवानाम् पुद्गलानाम् कालस्य उपकारो भवति ।)

(The function of time is to assist substances in their continuing to exist (*vartanā*), in their modifications (*pariṇāma*), in their movementss (*kriyā*)[246] and in their priority (*paratva*) and

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246. The Jain Acharyas have described 10 kinds of motions :

"प्रयोगबन्धाभावच्छेदाभिघातावगाहनगुरुलघुसंचारसंयोगस्वभावनिमित्तभेदात् ॥

(*Tattvārtha Rāja Vjavartika*. 5·24.)

Prayogagati—Motion of a projectile such as a bullet or a missile.

Bandhābhāvagati—Uncoiling of a spring or sprouting of a seed.

non-priority or juniority in time (*aparatva*).

In other standard Jain works the time has been defined as follows :

वत्तणालक्खणो कालो ।[247]

Vartanā (Assisting in their continuity of being) is the characteristic of time.

जीवादीदव्वाणं परिवट्टणकारणं हवे कालो ।।[248]

(That which helps all substances, soul, etc., in undergoing modifications, is time.)

वत्तणहेदू कालो वत्तनगुणमविय दव्वणिचयेसु ।
कालाधारेणेव य वट्टंति हु सव्वदव्वाणि ।।[249]

Time is the cause of continuity in being. The attribute of continued existence is in all the six realities of the universe. And all substances undergo change through the support of time.)

ण य परिणमदि सयं सो ण य परिणामेइ अण्णमण्णेहिं ।
विविहपरिणामियाणं हवदि हु कालो सयं हेदू ।।[250]

(Time never alters itself into other substances nor does it change other substances into itself. It is merely the auxiliary cause of different kinds of modifications in other substances.)

दव्वपरिवट्टरूवो जो सो कालो हवेइ ववहारो ।
परिणामादीलक्खो वट्टणलक्खो य परमट्ठो ।।[251]

Cheda Gati—Motion of sound waves as compressions and rarefactions in air.

Abhighāta Gati—Motion of particles during an explosion.

Avagāhana Gati—Motion in a resistive medium such as that of ships in a sea or of aeroplanes in the air.

Guru Gati—Free fall of a heavy body.

Laghu Gati—Motion of cotton flakes in air or Brownian movement.

Sañcāra Gati—Motion through diffusion.

Sanyoga Gati—Motion on horseback.

Svabhāva Gati—Natural motion of air, of the solar system and of the electrons inside an atom.

247. *Uttarādhyayan Sūtra*, 28·10.

248. *Niyamasāra*, 33.

249. *Gommaṭa Sāra*, Jīvakāṇḍa, 568.

250. Ibid, 570.

251. *Dravya Saṁgraha*, 21.

Practical or Apparent Time is that which is known from modifications produced in substances, while Real Time is that which helps to produce changes in substances and is understood from continuity.

According to Jains, time is divided into two classes Vyavahāra Kāla and Niscaya Kāla, i.e., Apparent and Real Time.

Apparent Time is defined as :

नवजीर्णादिपर्यायैर्द्रव्यानां यः प्रवर्तकः ।
समयादिमयः कालो व्यवहाराभिधोऽस्ति सः ॥[252]

Apparent Time consists of hours, minutes, seconds, etc., by which we call a thing to be new or old.)

Or

"व्यावहारिककालस्य परिणामस्तथा क्रिया ।
परत्वं चापरत्वं च लिंगान्याहुर्महर्षयः" ॥[253]

(The apparent time is known from the modifications (Pariṇāma) that it produces in substances and from the relations of the sun, the moon and the earth (Kriyā) and it is with the help of it that we determine (Paratva, Aparatva) antecedence or non-precedence in time of substances end events.)

Or from *Pañcāstikāya Sāra*, we have

कालो परिणामभवो परिणामो दव्वकालसंभूदो ।
दोण्हं एस सहावो कालो खणभंगुरो णियदो ॥[254]

(Apparent time is determined by changes or motions in things. The changes themselves are a result of Real or Absolute Time. The former has a beginning and an end, while the latter is eternal. The idealistic thinkers both in the east and in the west[255] regarded time as a mere appearance. Vedānta has no explanation to offer for Time and the Vaiśeṣika school regards time as merely the principle of change and not an actual substance.[256] It is referring to such doctrines that the author of *Candraprabha Caritam* has said :

252. *Vardhamāna Purāṇa*, 16·34.
253. *Tattvārtha Sāra*, 3·45.
254. *Pañcāstikāya Sāra*, 107.
255. See *Kant's Philosophy as rectified by Schopenhauer*, by M. Kelly.
256. See *The Hindu Realism*, p. 29.

क्रिया दिनकरादीनामुदयास्तमयादिकाम् ।
प्रविहायापरः कालो नास्तीत्येके प्रचक्षते ।[257]

(According to some there is no other time except that which consists of acts comprised by the rising and the setting of the sun.)

Then in contradiction of this view the author writes :

तन्न युक्तं क्रियायां हि लोके काल इति ध्वनिः ।
प्रवृत्तो गौणवृत्त्यैव वाहीक इव गोध्वनिः ॥
न च मुख्यादृते गौणकल्पना नरसिंहवत् ।
तस्माद्द्रव्यस्वभावोऽन्यो मुख्यः कालोऽस्ति कश्चन ।[258]

(Though in ordinary language, the word 'time' is used to connote such acts (i.e., the rising or the setting of the sun) but real time is quite different from it. There is a time having the characteristics of a reality behind apparent time.)

We shall speak more about Time as a Reality under Sūtra 39. For the present we shall confine our attention to the functions discharged by the Time substance. The characteristic function of Absolute Time is Vartanā. Vartanā has been explained as follows :

प्रतिद्रव्यपर्यायमन्तर्नीतैकसमया स्वसत्तानुभूतिर्वर्तना ॥[259]

Or

अन्तर्नीतैकसमया प्रतिद्रव्यविपर्ययम् ।
अनुभूतिः स्वसत्तायाः स्मृता खलु वर्तना ॥[260]

Or from Sarvārtha Siddhi

वर्तते द्रव्यपर्यास्तस्य वर्तयिता कालः ॥

i.e., Vartanā is the perception of the continuity of existence of a substance understood from the changes produced in it in separate moments of time. For instance, if a quantity of rice is boiled on fire, from the instant that we put the pot on the fire slow changes go on continuously till it is boiled. Through-

257. *Candraprabha Caritam*, 18·75.
258. Ibid, 18·76.
259. *Tattvārtha Rājavārtika*, on Sūtra 5·22.
260. *Tattvārtha Sāra*, 3·41.

out this period the perception of existence of rice is inferred. This is called Vartanā. It is true that the inference of the existence of real time is to be drawn from the existence of apparent time as in the case of the boiling rice.[261]

Thus we see that the substance, which enables things to continue in nature or that which helps other five Realities in their continuity, is called Time by Jainas. Just as the central iron pin of the potter's wheel is necessary for its revolving, so is time necessary for the 'revolution' of substances in nature. The question may be asked. If Time is the substance which assists things in their movements of continuity on what does Time itself revolve ? But the question is untenable. If Time were to depend on another substance for its continuance, the latter would require another substance to depend on and the chain would be interminable. It follows, therefore, that time exists by itself, and the things *continue* to be as a function of time.

In the *Key of Knowledge* by C. R. Jain we read the following forceful arguments in favour of Time as a substance :—

"It is obvious that no philosophy ignores the elements of continuity and succession can ever succeed in solving its mystery (that of Time). Most of the philosophies of the world have taken it to be synonymous with succession and, consequently, failed to understand its true nature. Some have even gone the length of eliminating it from the list of existing substances, forgetting that things continue and undergo changes of form only in Time, not otherwise. In one of its aspects, then, Time is the source of continuity and in the other a kind of force which makes it impossible for things to leap over succession and orderliness, by making them travel, point by point, or step by step, on the path of evolution. Take away Time as an all-pervading force from the universe, replace it in the form of capsules of energy in the individuals and you destroy the possibility of succession, i.e., orderly causation, at a stroke, since in a world without time things might well occur and vanish like the beautiful palace of Alladin of the Wonderful Lamp. Remove Time altogether from the world and you stop its

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261. सानुमानिकी व्यवहारिकदर्शनात् पाकवत् ।

(*Rājavārtika* on Sūtra 5·22)

evolution instantaneously, since no world-process is conceivable where continuity and succession are both conspicuous by their absence. Thus, from one point of view, Time serves as the mainspring of the *perpetuum mobile*, and, from another, keeps back the impish chance from playing its uncanny pranks with men and the things in the world".[262]

At this stage one is reminded of the great French philosopher, Bergson, who declared to the world that time was a potent factor in the evolution of the Cosmos. He was of opinion that changes and modifications are absolutely impossible without time element and so is the view of the Jain writers.

The view of modern science with regard to the 'passing' of time is well expressed by Richard Hughes :—

"The only way in which you can tell future from past is that you will find more chance[263] and higgledy-piggledy in it ! To take a simple case. Suppose I made a cinema-film, in which some children came into a tidy room and played about at random till it was thoroughly untidy and then left. Now it would be possible to show that film backwards—then you would see the children go into the room and romp about till it was thoroughly tidy—*but you would not believe it*, you would *know* the film was being run backwards. Well, the whole universe is a vast room, in which innumerable energy is arranged. To muddle thoroughly such an enormous room will take many æons. But the process is slowly and inexorably going on ; and it is this increase of muddle on the side of us, this decrease on the other, which we feel as a difference between past and future: this growing disorder which we call the 'passing' of time".[264]

It is this 'muddling' has been connoted by that word 'Pariṇāma' (modifications) in the main Sūtra and more clearly expressed in gāthā 750 of *Gommaṭasāra* quoted on page 117.

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262. *Key of Knowledge*, p. 758.
263. 'Chance' here means '*absence of orderliness*'.
264. *An Outline For Boys and Girls and Their Parents*, p. 343.

SŪTRA 23.

स्पर्शरसगन्धवर्णवन्तः पुद्गलाः ॥२३॥

SPARŚA-RASA-GANDHA-VARṆAVANTAḤ PUDGALĀḤ. (23)

(Pudgala or matter has four chief characteristics associated with it, viz., touch, taste, smell and colour.) In a standard Swetāmbara work we read as follows :

पोग्गलत्थिकाए पंचवण्णे दुगंधे पंचरसे अट्ठफासे पण्णत्ते ।[265]

(Pudgala is characterized by five kinds of colour, five kinds of taste, two forms of smell and eight kinds of touch.)

Ācārya Sakalakīrti expresses the same view in Vardhamāna Purāṇa as :

वर्णगन्धरसस्पर्शमयाश्चानन्तपुद्गलाः ।

Or in Pañcāstikāya Sāra :

वण्णरसगंधफासा परमाणुपरूविदा विसेसा हि ।
दव्वादो य अणण्णा अण्णत्तपगासगा होंति ॥[266]

Eight kinds of touch have been described as :

मृदुकठिनगुरुलघुशीतोष्णस्निग्धरूक्षस्पर्शभेदाः ।[267]

Soft, hard, heavy, light, cold, hot, smooth and rough

Rasa is of five kinds :

तिक्तकटुकाम्लमधुरकषाया रसप्रकाराः ।[268]

Bitter, sour, acidic, sweet and astringent. Smell is of two kinds:

गंध-सुरभिरसुरभिश्च ।[269]

Good smell and bad smell.

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265. *Vyākhyā Prajñapti*, 12·5·116.
266. *Pañcāstikāya Sāra*, 57.
267. *Tattvārtha Rajavārtika*, on Sūtra 5·23.
268. Ibid.
269. Ibid.

Colour of five kinds is described as :

नीलपीतशुक्लकृष्णलोहितभेदात् ।[270]

Blue, yellow, white, black and red.

After describing these 20 attributes of matter, the author of Sarvārtha Siddhi has added the following significant words :

त एते मूलभेदाः प्रत्येकं संख्येयासंख्येयानन्तभेदाश्च भवन्ति ।

(The foregoing 20 are the principal divisions. In fact each of these can be further sub-divided into finite, infinite and trans-finite ways.)

Let us now discuss these properties from the scientific point of view. Sparśa in the case of perceptible physical objects can be interpreted as the nature of the external surface, which may be smooth or rough, hot or cold, hard or soft, light or heavy.

These four pairs of sparśa guṇa or 8 kinds of touch mentioned above refer to the following four physical properties of modern science; Scale of hardness[271] (*mṛdu, kaṭhinas*) density (*guru, laghu*), temperature (Śīta, Uṣṇa) and crystalline structure (*snigdha, rūkṣa*)

The relative hardness of substances is determined by scratching one with the other. For instance, a piece of copper can be scratched with a piece of steel or a sheet of glass can be cut with a piece of diamond, so we say steel is harder than copper or diamond is harder than glass.

Modern chemist has grouped all kind of matter into 92 forms of chemical elements, of which the densities vary from element to element. Hydrogen is the lightest and platinum or osmium are amongst the heaviest elements known. Taking water as the standard substance, gold is about 19 times heavier

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270. Ibid.

271. In the Mohs' scale of hardness, substances have been arranged in the following order of increasing hardness :

Talc, Gypsum, Calcite, Flourspar, Apatite, Orthoclase felspar, Quartz, Topaz, Corundum and Diamond.

All these ten are naturally occurring crystals. The list shows that the diamond is the hardest known substance. Besides this instruments have been developed for measuring the infinite degrees of varying hardness in things. Scelerometer of Plaff and Micro-scelerometer of Jagger are the chief instruments employed for a description of which see *'Crystallography and Practical Crystal Measurement'* by A. E. H. Tutton (Macmillan).

volume for volume and osmium about 23 times. But as we have referred on page 13 ante forms of matter thousands of times denser than the densest substance on earth have been discovered in the interior of stars.[272] Just as in the case of hardness it is impossible to prepare a list of the infinite variety of substances of varying shades of hardness, so is found to be the case with densities of materials. The density of matter in nebulæ is extremely thin--of the order of 10^{-24}, i.e., $\frac{1}{1000000000000000000000000}$ of the density of water.[273] On the other hand, there are stars in which the density of matter is of the order 620 tons per cubic inch, i.e., 38440000 times denser than water. The same view has been expressed by H. Ward in a more mild tone thus:

"There are stars whose volume is a hundred million times that of our sun, composed of matter a million times less dense than the matter of our sun.[274] Also there are stars composed of matter two thousand times as dense as gold, so that a pint of it would weight nineteen tons."[275]

When one compares the lightest piece of matter existing in nature with the heaviest the above figures show that the latter is 3844000000000000000000000000000 times denser than the former. What surprise is there therefore when a Jain Ācārya declares :

प्रत्येकं संख्येयासंख्येयानन्तभेदाश्च भवन्ति ।

that the 20 attributes of matter have got a finite number of divisions from one point of view and an infinite number from another. If we regard matter in the form of 92 elements of the modern chemist, the attributes also assume a finite number, otherwise it is impossible to prepare a full catalogue of variations.

The third pair of attributes is śīta-uṣṇa. From a practical point of view when we speak of a body as feeling hot or cold we

272. "Astronomical evidence seems to leave practically no doubt that in the so-called 'White dwarf' stars the density of matter far transcends anything of which we have terrestrial experience; in the companion of Sirius, for example, the density is about a ton to the cubic inch".

—*The Nature of the Physical World*, by Eddington, p. 203.

273. *The Internal Constitution of the Stars* by Eddington, p. 332.

274. The mean density of the sun is only 1.3 relative to water.

275. *Exploring the Universe*, p. 11.

refer to its temperature. The range of temperatures existing in Nature is again very wide, and what little has come under the measuring rod of a physicist has revealed very striking contrasts. The temperature of ice physicists call zero and the temperature of boiling-water 100 degrees (Centigrade). The temperatures of bodies colder than ice are called minus temperatures and mathematical calculations show that the lowest possible temperature in Nature cannot be less than minus 273 degrees. Mercury hardens into a solid mass at minus 40 degrees. Just as the steam is converted into liquid water on cooling, so is air by artificial cooling converted into liquid air at minus 190 degrees. Helium gas is converted into liquid or solid helium at minus 269 degrees. Some other interesting temperatures are:

Gold melts at	1,062 degrees.
Platinum melts at	1,770 ,,
Tungsten ,, ,,	3,400 ,,
Temperature of burning charcoals	1,300 ,,
Temperature of electric carbon arc	3,500 ,,
Surface temperature of the sun	5,500 ,,
Central temperature of the sun	two crores ,,

Highest temperature estimated in stars by Eddington four crores of degrees.[276]

If we probe into our own atmosphere we find that the temperature gradually falls as one goes higher up until at about a height of 11 miles just over the equator temperature has a value minus 55 degree—a temperature well suited to petrify even mercury. Further on up to a height of 23 miles the temperature remains steady, beyond which it increases to that of spring season, i.e., about 30°C. This is enough to show that temperature of things is measurable from one point of view and the infinite shades of it, it is impossible to enumerate. The extremes of temperatures existing in the regions of the Hell are expressed in the following verse of Chaha Ḍhālā:

गिरि सम लोह् गलै जम जाय, ऐसी शीत उष्णता थाय ।

276. See *The Internal Constitution of the Stars*, by Eddington.

(Rocks of iron melt and freeze, such are the extremes of temperature in the hells.)

The last physical property which can be determined by touch is the smoothness or roughness of the surface of a body which fundamentally depends upon the arrangement of crystals in the surface. When a metallurgist examines the surface of a piece of steel under a microscope, he sees a hotch-potch arrangement of crystals which is responsible for the physical nature of the outer surface. It shows that the arrangement of crystals in things can assume infinite number of ways, although for practical purposes these groupings have been classified.

We shall now discuss the five kinds of taste:

Bitter, sour, acidic, sweet and astringent.

Bitter (Tīkta) like quinine.

Sour (Kaṭu), the result of unripeness in fruits.

Acidic (Amla) the taste of an acid such as the sulphuric acid or the tartaric.

Sweet (Madhura) like sugar.

Astringent (kaṣāya) the taste of red chillies.

These are physical properties associated with matter and should not be confounded with the well known ṣaḍ-rasa associated with articles of food. The latter are :

(milk, curd, ghee, sugar, oil and salt.)

Winifred Cullis, professor of physiology at the London School of medicine and Dr. E. E. Hewer in their article on physiology[277] describe the organ of taste as follows:

"We taste with the minute projections that can be seen with a lens on the surface of the tongue. These projections carry sensitive cells that are in connection with nerve fibres. Four tastes can be distinguished—salt, sweet, sour and bitter : sweet things are best appreciated at the tip of the tongue and bitter things at the back."

It appears that the learned doctors had never the opportunity of tasting red chillies, otherwise there would have been no difficulty in recognizing the astringent taste of these as quite separate from the four tastes enumerated by them.

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277. See *An Outline for Boys and Girls and Their Parents*, p. 81.

In recent years chemists[278] have been trying to find out the cause of this difference in taste. They have already investigated the cause of sweetness and have found that a particular arrangement of hydrocarbon elements is responsible for the sweetness. When work on this subject is pushed on further it is very likely that five different groups of elements which produce the five kinds of tastes mentioned above, will be discovered.

Coming to the subject of smell, there can be litttle dispute about the most artibrary division : good and bad smell. We smell with the help of the special hair cells at the back of the nose covering an area of about one sq. inch. In a dog the area of the cell is 10 sq. inches and in the case of a shark 24 sq. inches; hence their unusual powers of smelling. When the hair cells move by the impact of air reaching from outside, we perceive the smell. That smell is associated with every bit of matter is well illustrated by the phenomenon of 'Tele-olefaction.' An Instrument called the Electro-olefactory[279] cell has been designed which is "much more sensitive than the human nose and can detect the smell emitted by a burning of a small rag 100 yards away." With its help smell of flowers, etc., can be transmitted along the wires or by wireless from one place to another over a distance of 65 miles. This apparatus has been further used to operate any automatic fire control, so that if fire breaks out, say, in a cotton godown, the smell of fire reaches the electro-olefactory cell which, with the help of certain electrically worked levers, opens a spray of water, thus extinguishing the fire. The students of Vaiśeṣika school should note that there cannot be any clearer proof than this of fire emitting some sort of smell, which Jain writers have recognized. (See pages 61-62 ante.)

Lastly five kinds of colours have been associated with matter : Blue, yellow, white, black and red.

Some people who make much of the seven rainbow colours are apt to be misled by the five colours of Jain philosophy

278. Read the article "*Taste and Chemical Constitution*" by A. J. Mee, M.A., in '*Science Progress*', October 1934. In this article the author has clearly recognized five kinds of taste. Says he "In taste there are only five general classes—sweet, bitter, salt, sour and insipid." This agrees quite well with the Jain view.

279. See the paper read Sy B. D. Virmani, Bombay, before the *Science Congress*, Calcutta, 1935.

associated with matter (*pudgala*) but a little reflection will show that this enumeration of five colours is the most scientific and up-to-date. "As the temperature of a body is raised, it emits first of all infra-red radiation, then red light, then yellow light, and finally white light. If we could obtain even higher temperatures in the laboratory, we could make bodies 'blue hot' as is actually observed with some of the stars."[280]

Also in another standard work on the same subject by Dr. M. N. Saha, F.R.S., and B. N. Srivastava, we read on page 341.

"As the temperature of a body is raised, the colour emitted by it becomes more and more rich in waves of shorter wavelength. Some of the stars shine with a bluish white light which indicates that their temperature must be very high."

The infra-red rays, referred to in the above quotation from Barton's book, are the dark heat rays which do not produce the sensation of vision. These rays are present in what appears perfect darkness to us. The eyes of a cat or of an owl perceive with the help of infra-red rays, hence these animals can see in the dark. Recently Messrs. Ilford Ltd., have developed photographic plates, sensitive to infra-red rays with the help of which photographs can be taken in utter darkness. So long as the temperature is below the Draper point, 525°C. a body emits only infra-red rays ; in other words, it appears dark or black, then the colour changes to red, then yelow, then white and finally blue. It should be noted here that these colours are not pigmentary colours but the natural colours which any piece of Pudgala takes up at different conditions of temperature and they are only five and no more, viz. black, red, yellow, white and blue, which is identical with :

(वर्णः) स पंचविधः । कृष्णनीलपीतशुक्ललोहितभेदात् ।।[281]

Some are apt to think that green colour should not have been dropped out of the list of colours and black and white were unnecessary, since white is a mixture of green and red pigments and black means the absence of colours. While thinking in this strain it should not be lost sight of that the above five colours are not pigmentary. The three fundamental

280. *A Text-book of Heat*, by A. W. Barton, p. 361.

281. *Sarvārtha Siddhi*, on Sūtra 5.23.

colours for a canvas painter are red, green, and bluishviolet from which any desired colour can be produced by mixing these three powders in different proportions, whereas in tri-colour printing on paper red, yellow and blue are the colours required. Even in the case of colours of solar spectrum it can be demonstrated that if red light is cut off from the spectrum by an opaque screen and the remaining six colours then re-combined by a prism, the resulting light would be green, showing thereby that what appears to be green, is only white light minus red. Then there is also a distinction between a mixture of spectral colours and that of pigment colours. Blue and yellow light, when mixed, produce white light, whereas blue and yellow pigments, mixed together would produce a green paint. This discussion clearly shows that the above sūtra, describing the fundamental properties of matter, refers neither to spectral colours nor to pigmentary.

It may be mentioned in addition that the definition of 'colour' adopted by the *Optical Society of America* (see Report of the Colorimetry Committee, 1922) is as follows :

"Colour is the general term for all sensations arising from activity of the retina and its attached nervous machanisms. It may be exemplified by the enumeration of characteristic instances, such as red, yellow, blue, black and white......"

It shows perfect agreement with the Jain view.

Heart leaps with joy at the sight of this exact coincidence in the classification of these natural colours. The study of Nature by our forefathers appears to be no less critical than the modern.

With regard to the infinite gradations of these five colours (vide page 123 ante), one word may be said about the fundamental nature of colour. Just as a difference of wave-length[282] in sound produces difference of note, similarly difference of wave-length is visible light produces difference of colour. "It is usual to regard light as a wave-motion, each wavelength corresponding to a definte colour" (—Max Born). The shortest light-waves that the human eye can see are the waves of violet light. As

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282. *Sound and light energies travel in space in the form of waves. The most common form of wave is one which is produced over the surface of a pond by dropping a piece of stone. The distance from one wave-crest to another is called the wave-length.*

they increase in length one passes the rainbow : violet becomes blue, blue becomes orange and orange becomes red. When they lengthen beyond that they become too long for the human eye to see and the body appears dark. The red waves are only $\frac{1}{30,000}$ of an inch long whereas the violet waves are only half as long, i.e., $\frac{1}{60,000}$ of an inch. The waves of other colours have lengths intermediate between these values. On the average it may be said that light waves have lengths about $\frac{1}{100}$ of the diameter of human hair, the latter being about 1/400 of an inch. If a lightwave differs from another light-wave in length even by an infinitesimal amount they are said to belong to two different colours. Thus from this point of view the number of colours is truly infinite and so is the version of Jain Ācāryas as quoted on page 123 ante.

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SŪTRA 24.

शब्दबन्धसौक्ष्म्यस्थौल्यसंस्थानभेद-
तमश्छायाऽऽतपोद्योतवन्तश्च ॥२४॥

ŚABDA-BANDHA-SAUKṢHMYA-STHAULYA-SANSTHĀNA-BHEDA-TAMAŚCHĀYĀ-TAPODYOTAVANTAŚCA. (24)

(शब्द-बन्ध-सौक्ष्म्य-स्थौल्य-संस्थान-भेद-तमः-छाया-आतप-उद्योत-वन्तश्च पुद्‌गला भवन्ति ।)

Manifestations of Pudgala (Matter) take the form of sound, union, fineness, grossness, figure, divisibility, darkness, shade or image, sunshine and moonlight.

In the Uttarādhyayana Sūtra of the Swetāmbaras the idea of this Sūtra together with that of the previous Sūtra is expressed in the following words :—

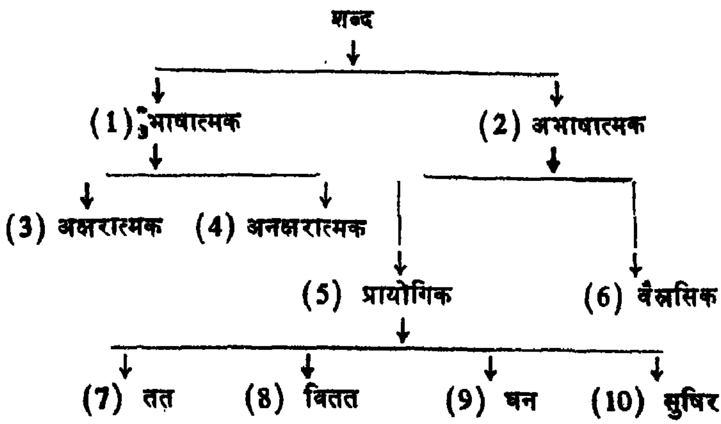
सद्दन्धयार-उज्जोओ पहा छायातवे इ वा ।
वण्णरसगन्धफासा पुग्गलाणं तु लक्खणं ॥
एगत्तं च पुहत्तं च संखा संठाणमेव च ।
संजोगा य विभागा य पज्जवाणं तु लक्खणं ॥[283]

We have already referred to the scientific view of Jain Ācāryas with regard to the production of sound on pages 70 and 71.

The following is the classification of sounds :

शब्दो द्वेधा भाषालक्षणविपरीतत्वात् ।
भाषात्मक उभयथा अक्षरीकृतेतरविकल्पात् ।
अभाषात्मको द्वेधा, प्रयोगविस्रसानिमित्तत्वात् ।
(तत्र वैस्रसिको बलाहकादि-प्रभवः) ।
प्रयोगश्चतुर्धा, ततविततघनसौषिरभेदात् ॥[284]

Expressed in the form of a table, we have :



(1) Bhaṣātmaka—Sound incorporated in languages.

(2) Abhāṣātmaka—Sound which does not find place in any language.

(3) Akṣarātmaka—Articulate utterance or speech.

(4) Anakṣarātmaka—Sounds made by creatures or by the

283. *Uttarādhyayana Sūtra*, 28·12-13.

284. *Tattvārtha-rājavārtika* on Sūtra 5·24.

Kevalis.[285]

(5) Prāyogika—Sounds produced by human beings with the help of musical instruments, i.e., musical sounds.

(6) Vaisrasika—Natural sounds such as the roar of the thunder or the rippling of water and the noises in general.

(7) Tata—Musical sound of the *tabalā* or the drum i.e., a stretched membrane.

चर्मतननिमित्तः पुष्करभेरीदर्दुरादिप्रभवस्ततः ।[286]

(8) Vitate—Musical sounds of stringed instruments.

तंत्रीकृतवीणासुघोषादिसमुद्भवो विततः ।[287]

(9) Ghana—Musical sounds from reed instruments such as the harmonium or the xylophone. The sounds from bells are also included in this class.

ताल घंटालालनाद्यभिघातजो घनः ।[288]

(10) Suṣira—Sounds produced from wind instruments, organ pipes or the conch.

वंशशंखादिनिमित्तः सौषिरः ।[289]

It is necessary to mention here that the Jain terminology for sounds of musical instruments is a bit different. For Vitata they call Tata and for Tata, Ānaddha. See the following couplet from *Amarakośa* :

ततं वीणादिकं वाद्यमानद्धं मुरजादिकम् ।
वंशादिकन्तु सुषिरं कांस्यतालादिकं घनम् ।

In modern accoustics the study of sound is divided into two main classes : Musical sounds and Noises. All the classes

285. Kevalis are the persons who attain perfection of knowledge. Lord Pārśva and Lord Mahāvīra are examples in recent times. It is said that their speeches were given in terms of a rythmic note generated by the vibration of the whole body which could be analysed by men and animals into their respective languages. It is difficult to find an exact analogue of this but it may be compared to the analysis of a complex wave-form of sound into its Fourier components by a harmonic analyser—a mechanical machine,

286. *Sarvārtha Siddhi*, on Sūtra 5·24.

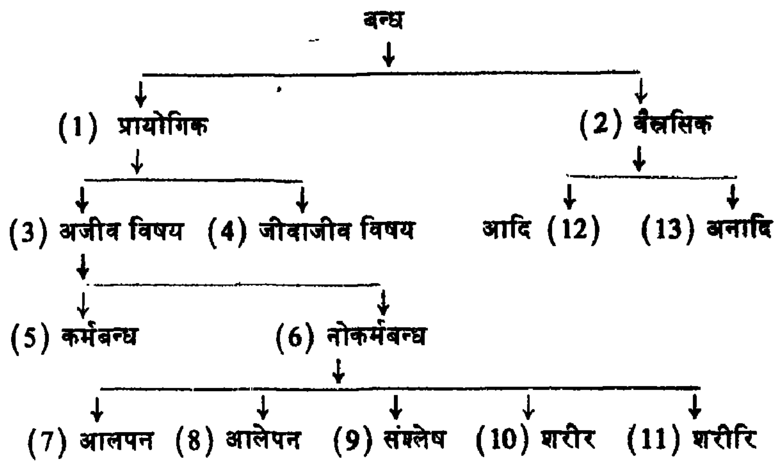
287. Ibid.

288. Ibid.

289. Ibid.

enumerated on page 131 ante are included in Musical Sounds and class No. 6 (vaisrasika) includes the Noises. Noise is defined by modern science as the sound 'undesired by the recipient'. The sub-divisions of musical sounds include the vibrations of membranes, strings, rods and plates and air columns. These are respectively Tata, Vitata, Ghana and Suṣiras (See any text-book on sound).

Union of matter has been classified as follows:—



(1) Prāyogika—Union produced by the efforts of the body, speech or the mind of a person.

(2) Vaisrasika—Union produced without any effort of a person.

(3) Ajīva viṣaya—Union of one kind of matter with another (chemical reactions belong to this class).

(4) Jivājīva-Viṣaya—Union of matter with spirit.

(5) Karma bandha—Union of Karmic matter with soul. (For Karmic matter read pages 71 et seq.)

(6) No-karmabandha—Physical combinations.

(7) Ālapana—As the fastening of a chain to a chariot.

(8) Ālepana—Painting over a canvas or mural painting.

(9) Sanśleṣa—Dovetail joints in pieces of timber.

(10) Śarīra—Ligamentary joints of living body.

(11) Śarīri—Union of two bodies.

(12) Ādi vaisrasika bandha—That which has a beginning and has resulted from a definite cause, such as the union of

different colours in a rainbow. Production of lightning, the shooting stars, and the formation of the clouds are also included in this class. For we read in *Sarvārtha siddhi* as follows :

वैस्रसिकः । तद्यथा-स्निग्ध-रूक्षत्वगुणनिमित्तो विद्युदुल्का-जलधाराग्नीन्द्र-धनुरादिविषयः ।[290]

(Tr.—The production of lightning due to the mixing of positive (snigdha) and negative (Rūkṣa) electric charges, the meteoric showers, the rainfall, the production of fire and the formation of the rainbow are examples of this class of combination in matter.

(13) Anādibandha—Eternal union as the union of the different parts of substances like Dharma, Adharma and Ākāśa.

The other modifications of matter are Soukṣmya and Sthoulya, i.e., fineness and grossness. The author of *Tattvārtha Rājavārtika* says :

सौक्ष्म्यं द्विविधम्, अन्त्यमापेक्षिकं च । तथा स्थौल्यम् ।[291]

(Fineness and grossness are each of two kinds अन्त्य (extreme) and आपेक्षिक (Relative).

Further from Sarvārthasiddhi on this Sūtra :—

तत्रान्त्यं परमाणूनाम् । आपेक्षिकं बिल्वामलक-बदरादीनाम् ।। स्थौल्यमपि द्विविधम् अन्त्यमापेक्षिकं चेति ।। तत्रान्त्यं जगद्व्यापिनि महास्कंधे । आपेक्षिकं बदरामलकबिल्वतालादिषु ।।

(The Paramāṇus furnish the examples of extreme fineness in matter and *the universe itself constitutes the biggest molecule of matter* (Mahāskandha). There is nothing smalier than Paramāṇu and nothing bigger than the universe in the world of matter. Besides we talk of relative sizes : for instance, jejubes are smaller than Bel fruit or a cocoanut is bigger than a plum and so on.)

Sansthāna[292] is the shape of a body ; it may be regular geometrical shape, circular, triangular or rectangular, etc., or it may be an irregular body as the shape of the clouds.

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290. Ibid.

291. *Tattvārtha Rājavārtika*, on Sūtra 5'24.

292. संस्थानं द्वेधेत्थं लक्षणम्, अनित्थंलक्षणं च । वृत्त-त्र्यस्रचतुरस्रायतनपरिमंडलादीत्थ-मतोन्यदनित्थम् ।

(*Tattvārtha Rājavārtika* on Sūtra 5'24(

(Bheda) means division. It is of six kinds :

उत्कर-चूर्ण-खण्ड-चूर्णिका-प्रतराणुचटनविकल्पात् ॥[293]

Utkara—Effecting separation as in sawing a piece of timber.
Cūrṇa—As the grinding of wheat into powder.
Khaṇḍa—As the separate parts of a broken pitcher.
Cūrṇikā—As the separation of chaff from rice or pulses.
Pratara—As the separation of layers in a sheet of mica.
Aṇucaṭana—As the smithereens of a blacksmith's workshop.

This appears to be a beautiful classification of the physical processes of dividing things into parts.

Tamaḥ is defined as "तमोदृष्टिप्रतिबंधकारणं प्रकाशविरोधि ।"[294] it is the antithesis of light and is the cause of invisibility of things. Some people think that the existence of darkness should not be regarded as separate from light. They think that the negation of light is darkness. However it is not so. As indicated on page 128 ante. Even in perfect darkness infra-red rays exist and though they do not effect our eyes, they can be perceived by the eyes of a special photographic plate. Without the presence of these 'dark rays' photography in pitch darkness would have been impossible. So darkness has a separate existence from visible light.

About Chāyā we read as follows :

छाया प्रकाशावरणनिमित्ता । सा द्वेधा, वर्णादिविकारपरिणता प्रतिबिम्बमात्रात्मिका चेति ।[295]

On pages 69 we have considered the interpretation of Chāyā. The author of the above commentary tells us that Chāyā is of two kinds : Virtual images produced by a plane mirror which show the object laterally inverted, i.e., left side becoming right and *vice versa* and the uninverted images like shadows or the images of a modern cinema screen. The production of shadows is also correctly explained as due to the obstruction (Āvaraṇa) of light.

Lastly the division of light energy into two categories ; Ātapa and Udyota, is based on scientific considerations : Ātapa is the sunlight or light of a fire, or electric lamp, etc., and

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293. Ibid.
294. *Sarvārtha Siddhi*, on Sūtra 5·24.
295. Ibid.

Udyota, is the moon-light, the light emitted by the jewels or the phosphorescent light of the fire-fly.[296] The former predominates in heat rays and the latter in light rays. The efficiency of modern electric lamp is only 7-10% and that of an arc lamp 15%.[297] In other words, only 7 or 15 per cent of energy is converted into light and the rest appears in the form of heat. Thus the light given by these sources has a much greater proportion of heat than light, and hence the name Atapa. The same is the case with the sun where only 35 per cent of the radiation appears in the form of light. The efficiency of the tiny lamp in the body of the glow-worn is 99 per cent. In other words, the light given by a glow-worm contains 99 per cent of light rays and 1 per cent of heat rays ; hence the most proper name given to it is Udyota. Surely this division reflects credit on the keen observation and discriminative power of the ancient thinkers.

SŪTRA 25.

अणवः स्कन्धाश्च ॥२५॥

AṆAVAH SCANDHĀŚCA (25)

(Matter exists in the form of indivisible elementary particles and their combinations.)

Some writers have translated aṇu as an 'atom' and skandha as a 'molecule' of modern chemistry. We have already discussed the definition of an *aṇu* as given by Jain thinkers on pages 73 and 74 and pointed out that an *aṇu* is the last particle of matter which cannot be sub-divided any further by any means whatsoever. Hence it cannot be identified with the modern conception of atom although the word 'atom' originally meant something indivisible.

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296. आतपः आदित्यादिनिमित्त : उष्णप्रकाशलक्षणः ।
उद्योतश्चंद्रमणिखद्योतादिप्रभवः प्रकाशः । (Ibid)

297. In the tube lightlamps the efficiency has reached about 60%.

Following elementary particles are known to the modern science:—

1. Negative elementary charges called the electrons.
2. Positive elementary charges of the same mass called the positrons.
3. Positive elementary charges 1,850 times as heavy called the protons.
4. Elementary particles of matter without any electric charges and of a mass slightly greater than that of the protons called the neutrons.
5. Heavy electrons.
6. Neutrino—A particle of rest-mass zero without any electric charge.
7. Negative elementary charge with mass equal to that of the proton called negative proton.
8. Mu-Mesons-positive and negative, 200 times heavier than the electron with mean life 10^{-7} seconds which ultimately decay into electrons.

   Many more about 100 of them have been discovered so far.

As Prof. Max Born has said "the existence of first four is firmly established; "two light ones, the electron and the positron and two heavy ones, the proton and the neutron". He further adds that "these are too many. For it is likely that combination of

a proton and an electron	will give	a neutron
a neutron and a positron		a proton.

Either neutron or proton must be composite."[298]

Further in the same book[299] we read that the nucleus of an atom is composed of protons and neutrons and the electrons and protons which occasionally fly out of the nucleus arise from the following transformations:—

Proton breaking into Neutron + Positron, and Neutron-breaking into Proton + Electron.

These considerations show that the electron and the positron are the only *non-composite* elementary particles of modern

298. *Restless Universe* by Prof. Max Born, p. 266.
299. Ibid. p. 275.

science and hence they can be identified with the two types of Paramāṇus described by Jain writers: the Kāraṇa paramāṇu and Kārya Paramāṇu. Shri Kundakundācārya writes in Niyamasāra:

धाउचउक्कस्स पुणो जं हेऊ कारणंति तं णेयो ।
खंधाणां अवसाणो णादव्वो कज्जपरमाणू ।।[300]

The idea of Kārya and Kāraṇa Paramaṇus seems to be further supported by the following quotation from Professor Born's book (Restless Universe p. 265)

"When light elements are bombarded by gamma-rays, electrons-pairs are observed to appear in the Wilson chamber, a positive electron and a negative electron shooting out from the same place." The question has been raised by the learned professor "Why is a positron always accompanied by a negative electron" and he says that the answer to this question has been given by the theory of Dirac. Since there can be no action (Kārya) without cause (Kāraṇa), a Kārya paramāṇu (positron) must always be accompanied by a Kāraṇa Paramāṇu (an electron). The names seem to fit in very well.

The Vaiśeṣika school of philosophy also regarded atom as the final indivisible unit. "The mote which is seen in a sunbeam is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself; and this likewise is a substance and an effect, for the component part of a substance which has magnitude must be an effect. This again must be composed of what is smaller and that smaller thing is the atom. It is simple and uncomposed, else the series would be endless and were it pursued indefinitely, there would be no difference of magnitude between a mustard seed and a mountain or a gnat and an elephant, each alike containing an infinity of particles."[301] This is the chain of arguments given by *Riśi* Kaṇāda in favour of an ultimate indivisible atom.

The author of *Pañcāstikāya sāra* defines a Skandha as :

खंधो परमाणुसंगसंघादो ।[302]

300. *Niyama Sāra*, 25.
301. Quoted from *The Key of Knowledge*, p. 22-23.
302. *Pañcāstikāya Sāra*, 86.

'an aggregate of atoms'[303] and further in *Sarvārtha siddhi* we read:

स्थूलभावेन ग्रहणनिक्षेपणादिव्यापारस्कन्धनात्स्कन्धा इति सञ्ज्ञायन्ते ।

(The molecules possess a gross form and undergo processes of association and dissociation.)

Then the Skandhas are of two kinds: Bādara (those that can be perceived by the senses) and Sūkṣma (those minute ones beyond sense perception as enumerated in the following verse:

बादरसुहुमगदाणं खंधाणं पुग्गलोत्ति ववहारो ॥[304]

With regard to Skandhas composed of only two elementary particles it said :

अयोग्येष्वपि द्वयणुकादिषु स्कन्धाख्या प्रवर्तते ॥

(Although the power of uniting or separation is absent in combinations composed of only two elementary particles, they are still called Skandhas.)

The neutrons as belonging to this class have already been referred to on page 65 and a proton can also be looked upon as a combination of concentrated positive charges or a compound of neutrons and positrons. Strictly speaking such elementary particles belong to the class called Skandhapradeśa. See the following gāthā of *Gommatsāra.*

खंधं सयलसमत्थं तस्स य अद्धं भणंति देसोत्ति ।
अद्धद्धं च पदेसो अविभागी चेव परमाणू ॥[305]

The smallest piece of matter embodying all the characteristic properties of a substance is the complete molecule, Skandhadeśa can be identified with modern atoms and dissociated molecules in solutions or the molecules in ionic state; Skandhapradeśas include the neutrons, the protons, the heavy electrons and the stripped atoms; and the paramāṇus are the electrons and the positrons. See also verses 80-81 quoted on page 7 ante.

303. Atoms in the sense described above, i.e., an elementary indivisible particle.

304. Pañcāstikāya Sāra, 82.

305. *Gommata Sāra*, Jīvakāṇḍa, 604.

Another very striking and beautiful point mentioned in Gommatasāra.

पोग्गलदव्वम्हि अणू संखेज्जादी हवंति चलिदा हु ।[306]

Elementary particles inside an atom and the molecules in a piece of matter are all in a state of motion. This is exactly the version of the modern dynamical theory and the electron theory of matter.[307] The molecules are then further divided into 23 vargaṇās, molecules composing the specialized physiological cells and others for details of which see Gommatasāra (Jīva-kāṇḍa), S.B.J., Vol. V.

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SŪTRA 26.

भेदसंघातेभ्य उत्पद्यन्ते ॥२६॥

BHEDA-SANGHĀTEBHYA UTPADYANTE (26)

Molecules are formed in three different ways—

(1) by Bheda (division),

(2) by Sanghāta (union or sharing), and

(3) by the combined process of division and union taking place simultaneously.

The advanced researches in physical chemistry have also revealed three processes of molecule formation. We quote the following from an article of A. J. Mee, M.A., B.Sc.[308]

"The question to be answered is, in what ways are atoms united in the molecule? The electronic theory of valency is able to supply a very satisfactory answer. According to this theory, there are three methods of linking atoms. The linkage

306. *Gommata Sāra*, Jīvakāṇḍa, 593.

307. This view is further supported from Vārtika 16, Sutra 7 of *Shri Tattvārtha-Rāja-vārtika* :

पुद्गलानामपि द्विविधा क्रिया विस्रसा प्रयोगनिमित्ता च ।

(Two kinds of motions are found in matter, one due to natural causes as in the case of the motion of the molecules in a gas or the motion of the electrons in atomic orbits and the other is generated by the external forces.)

308. *The Structure of Molecules*, appeared in the *Science Progress* (London), April 1935.

may be electrovalent, co-valent or co-ordinate......

"Molecules with an electrovalent linkage are ionised even in the solid state, x-ray analysis of the crystal indicating that the elementary particles making up the crystal lattice are ions and not atoms or molecules......Nearly all inorganic salts are electrovalent compounds."

The second arrangement, i.e., co-valent linkage is found in organic compounds. The atoms attain stability by a process of sharing electrons. For instance, in the case of the methan gas CH_4 the carbon atom attains a stable arrangement by sharing four electrons with the four electrons of the four hydrogen atoms. The third type of linkage, the co-ordinate linkage, involves the sharing of two electrons but both are supplied by the same atom. The process of the formation of a co-ordinate linkage *resembles both transference and sharing.* Therefore the three modern processes are transference, sharing and combined transference and sharing. The comparison is striking indeed !

Further the division of molecules takes place through the instrumentality of two causes : internal and external, for says the author of *Sarvārtha siddhi* ;

द्वितयनिमित्तवशाद्विदारणं भेदः ।

The phenomenon of radio-activity, explained in pages 43 et seq and illustrated in Fig. 4, is an example of the breaking of a molecule (a modern atom) due to *internal causes* which even the scientists have been able to elucidate. We read in the 'Restless Universe,' p. 238 : "We may cherish the opinion that there must ultimately be some *inner* reason for the fact that one atom lives only a few seconds and its apparently identical neighbour many years ; but no one has yet succeeded in putting his finger on the cause."

The examples of breaking under external stresses are four :

(1) Dissociation of molecules in solution.

"The modern dissociation theory supposes that when the salt (copper sulphate) is dissolved some or all of its molecules are dissociated into Cu...(copper) and SO_4'' (sulphate) ions, which move freely in the liquid ; the molecules in this condition

are said to be ionised."[309]

(2) Thermal ionisation or breaking under high temperatures. Read pages 8-9 and 12 ante.

(3) Pressure ionisation or breaking under high pressures. The phenomenon was discovered by Dr. D. S. Kothari—a Jain physicist of world fame.

(4) Breaking under artificial bombardment.

Read pages 44 et seq.

Sanghāta has been defined as :

पृथग्भूतानामेकत्वापत्तिः संघातः ।

The union of separate entities is Sanghāta the assemblage of neutrons, protons and electrons to form atoms, atoms uniting to form molecules are examples of Sanghāta.

The joint process of Bheda and Sanghāta is described as follows :

भेदसंघाताभ्यामेकसमयिकाभ्यां द्विप्रदेशादयः स्कन्धा उत्पद्यन्ते ।
अन्यतो भेदेनान्यस्य संघातेनेति ॥[310]

(By simultaneous separation and union molecules occupying two cells in space (Pradeśas) are produced. Just when one molecule breaks, the detached part attaches itself to another molecule.)

Compare this with the phenomenon of 'ionisation' in gases :

"The act of ionisation in gases really consists in the detachment of an electron from a neutral atom of the gas........ The detached electron soon attaches itself in a gas to a neutral atom." It is in this manner that positive and negative ions are formed.

Is not the coincidence surprising ? Still one is apt to disbelieve that the phenomenon of ionisation in gases was known to the ancients.

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309. *A Text of Physics* by R. S. Willows, p. 396.

310. *Sarvārtha Siddhi*, on Sūtra 5·26.

SŪTRA 27.

भेदादणुः ॥२७॥

BHEDĀDAṆUH. (27)

(भेदात् अणुरुत्पद्यते ।)

The ultimate elementary particles are produced only by division of matter (to an infinite extent not by the process of union or fusion).

The same view is expressed in a fuller statement :

अणोरुत्पत्तिर्भेदादेव, न संघातान्नापि भेदसंघाताभ्यामिति ।[311]

The *aṇu* of the ancients is very clearly defined by the author of *Sarvārthasiddhi* under Sūtra 25 as below:

"सौक्ष्म्यादात्मादय आत्ममध्या आत्मान्ताश्च ॥ उक्तं च :

अत्तादि अत्तमज्भं अत्तंतं णेव इंदिये गेज्भं ।

जं दव्वं अविभागी तं परमाणुं विआणाहि ॥[312]

(Owing to its smallness in size, the *aṇu* is in itself the beginning and the end ; it is beyond sense perception, i.e. cannot be seen with the eyes[313] and is the ultimate indivisible entity.)

And it is a fact that no instrument has been evolved by science so far, which would reveal before the eyes even the modern atom, what to say of aṇus, the ultimate elementary particles, the electrons and the positrons. This point is well brought out by John Pilley, Professor at Bristol University, under the sub-heading "Do atoms really exist ?"[314]

"We can't see atoms either and never shall be able too. This is because light, though you would not think it, is made up of waves......ordinarily you think of light going in straight lines

311. *Sarvārtha Siddhi,* on Sūtra 5·27.

312. Ibid, on Sūtra 5·25.

313. In recent years, electron microscopy has been able to show single atom images. Now C. L. Ritz and L. S. Bartell of Michigan University (U.S.A.) have designed a two-stage instrument that combines electron microscope techniques with holography. By this means the atom was magnified 50 crore times and thus they have succeeded in photographing the so-called atoms of neon and argon (*Science Today,* June 1974, p. 10).

314. *An Outline for Boys, Girls and Their Parents,* (Gollancy, Section : Chemistry), p. 261.

but actually it bends round corners a little just as sea waves do. This has the effect of giving everything you look at a tiny blur at the edge. But the blur is so narrow that you can never ordinarily see it. If you make a microscope to see extremely small things you find that you begin to see the blur. But, long before you get to the point where you would be able to see atoms the things you look at are entirely lost in the blur. *It is this that makes it impossible ever to see atoms.* Even if they were a million times bigger it would still be impossible to see them even with the most powerful microscope that has been made."

The above quotation shows forcefully the truth of the statement : 'णेव इंदियगेज्झम्' (beyond sense perception) with reference to the Paramāṇus.

We have already given arguments under Sutra 25 for identifying *aṇus* with electrons and positrons.

In *Pañcāstikāya Sāra* the following properties are associated with paramāṇus :

एयरसवण्णगंधं दोफासं सद्दकारणमसद्दं ।
खंधंतरिदं दव्वं परमाणुं तं वियाणीहि ॥[315]

(The substance, which has a single taste, a single colour, one smell and two kinds of *sparśa* (cutaneous sensation), which is the cause of sound, itself unsounding, which is different from skandhas (aggregates of elementary particles and atoms), through constituting them, is the paramāṇu.)

According to Jain philosophy the full visual knowledge of the ultimate elementary particles of matter is a metempirical subject and can be the subject of experience of a person endowed with clairvoyant perception but since these are perfectly real entities five physical attributes out of the 20 mentioned on page 123 are always associated with them.

As we have explained on page 128 et seq. the natural colour of matter depends upon the temperature conditions and the latter vary from one piece of matter to another. For instance, an electron on the surface of the earth and one in the body of the sun or the star differ extremely widely in temperature and hence different colours must be associated with them. So it is said

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315. Pañcāstikāya Sāra, 88.

that one of the five colours enumerated before is associated with *aṇus* depending upon temperature. The *aṇu* has one of the five tastes (See page 126 ante) and a smell, agreeable or disagreeable. Then further it my be *Snigdha or rūkṣa*; these terms when applied to the elementary particles refer to the positive or the negative charge of electricity. Thus one colour, one taste, one smell, temperature and the nature of electric charge are the five qualities associated with the tiniest piece of matter. The various combinations of these five attributes give rise to 200 different phases of elementary particles but identical in their intrinsic nature.

It is further worthy of notice that the properties of hardness and softness, heaviness and lightness are not associated with *aṇus* by the Jain thinkers :

"Of the eight contact qualities hard and soft, heavy and light are the qualities of skandhas. These cannot be in the atom."[316]

It is true that hardness and softness can be associated only with a little mass 'molecule' of matter—a property which is generated by the loose or compact aggregation of Paramāṇus, and because all Paramāṇus, whether of the form electron or that of the positron, have the same mass there arises no question of light and heavy amongst the elementary grains of matter. This difference in mass is found only amongst the *skandhas*, the atoms of modern chemistry. As is well-known the 92 kinds of atoms, each has a different weight, called the atomic weight. For instance, if an atom of gold weighs 196, that of mercury 200.

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SŪTRA 28.

भेदसंघाताभ्यां चाक्षुषः ॥२८॥

BHEDA-SANGHĀTĀBHYĀṂ CĀKṢUṢAḤ (28)

(Molecules are sometimes produced by the combind action of division and union which can be seen with the eyes.)

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316. *Pañcāstikāya Sāra*, (ed. Prof. A. Chakravarti) pp. 86-87.

Says the author of *Sarvārtha-siddhi* :

अनन्तानन्तपरमाणुसमुदयनिष्पाद्योपि कश्चिच्चाक्षुषः, कश्चिदचाक्षुषः ।

(Molecules composed even of an infinite number of elementary grains (Paramāṇus) some of them are visible and some invisible.)

How the visible molecules are produced, the same author says :

सौक्ष्म्यपरिणतः पुनरपरः सत्यपि तद्भेदेन्यसंघातान्तर-संयोगात्सौक्ष्म्यपरिणामोपरमे स्थौल्योत्पत्तौ चाक्षुषो भवति ।

(If a molecule breaks and the broken part then attaches itself to another molecule the resulting combination may be coarse enough to be seen with the eyes.)

Any number of illustrations can be given from text-books on chemistry. For instance, molecules of hydrogen and chlorine gas are invisible to the eyes but when each of them combines to form two molecules of hydro-chloric acid, the thing becomes visible and even the molecules can be recognized through an ultra-microscope. The reaction can be represented symbolically as

$$H_2+Cl_2=2\ HCl.$$

i.e., (Hydrogen mol.+chlorine mol.=2 mol. of hydrochloric acid.)

On page 142 we have explained the phenomenon of ionisation of air. When a beam of X-rays is sent into an air chamber, air becomes ionised, i.e., charged particles—positive and negative are produced by detachment and attachment of electrons and as in Millikan's famous oil-drop experiment, the 'handing on of these charges from molecules of gas to drops of oil and vice versa can be seen with the telescope' (Hutchingson). This is another example of the production of visible molecules (ions) by the combined process of division and union.

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SŪTRA 29.

सद् द्रव्यलक्षणम् ॥२९॥

SAD DRAVYA-LAKṢAṆAṂ (29)

(The differentia of a substance or Reality is Sat, isness or being.)

Also in *Vyākhyā-Prajñapati* (8·9 satpadadvāra) we have :

सद्द्व्वं वा ।

(Sat is the characteristic of a substance.)

It should be noted, however, that the six dravyas of Jain philosophy, although possessing the common characteristic of Sat, are fundamental and cannot be intra-converted.

The following Sūtra defines *Sat*.

●

SŪTRA 30.

उपादव्ययध्रौव्ययुक्तं सत् ॥३०॥

UTPĀDA-VYAYA-DHRAUVYA-YUKTAṂ SAT (30)

Sat is characterised by the concomitant processes of *Utpāda, vyaya* and *dhrauvya. Utpāda* means coming into existence—birth. Vyaya means going out of existence—death, and Dhrauvya means permanence. *Dhrauvya* is further defined in the following Sūtra.

●

SŪTRA 31.

तद्भावाव्ययं नित्यम् ॥३१॥

TADBHĀVĀVYAYAṂ NITYAṂ (31)

Permanence means indestructibility of the essence or the quality of the substance.

The subject matter of these three Sūtras 29, 30 and 31 has already been sufficiently dealt with in pages 51-55 and 77-80 ante.

In the former it has been explained and established on the authority of modern science that matter is constantly undergoing change, new modifications appearing and the old ones disappearing and at the same time maintaining its intrinsic nature through all these changes. This has been proved to be the fundamental characteristic of all matter. In the latter pages has been explained the way in which this characteristic is exhibited in non-material substances, the media of motion and rest, space and time, showing that *utpāda*, *vyaya* and *dhrauvya* are the instrinsic qualities possessed by all substances, material and non-material, if they are to be classed amongst the list of substances.

In the case of the soul substance, so long as it inhabits a corporeal body, it is always associated with grains of karmic matter (see page 71-72 ante). As a result of changes in our thoughts, emotions and other activities old karmic matter is being continually shed off the soul and an influx of new grains going on simultaneously, while the soul retains its essential qualities throughout these changes. This is called the *paranimitta* kind of Utpāda, Vyaya, and Dhrauvya, i.e., one which takes place through the agency of an external cause while the changes in Dharma and Adharma dravyas, etc., are of the *svanimitta* kind —without the aid of any external source.

Even in the case of a pure, disembodied soul Svanimitta kind of the three-fold phenomenon of origination, destruction and continuance goes on in thought-activity, since Jainism regards this phenomenon as the inevitable quality of a substance.

We cannot conclude this commentary without quoting the words of Mr. V. R. Gandhi :

"Noumenon and phenomenon are not two separate existences but only two modes of our looking upon the full contents of a thing, part of which is known and part unknown to us now. The fallacy in the popular mind in reference to these terms is that of confounding logical distinction with an actual separation. In the Buddhist view nothing is permanent. Transitoriness is the only reality. As Professor Oldenberg says: 'The speculation of the Brahmanas apprehended being in all being, that of Buddhists becoming in all apparent being.'

"The Jains, on the contrary, consider being and becoming as two different and complementary ways of our viewing the same thing. Reality in the Jain view is a permanent subject of

changing states. To be, to stand in relation, to be active, to act upon other things, to obey law, to be a cause, to be a permanent subject of states, to be the same today as yesterday, to be identical in spite of its varying activities, these are the Jain conceptions of reality. Mere becoming is asmuch an abstraction as mere being. In short, being and becoming are complements of the full notion of a reality."[317]

To many a mind the co-existence of this triple phenomenon may seem an obvious contradiction in terms but, according to Jain logic all contradictory statements are not necessarily hostile to one another (Syādvāda theory of Jains). This is expressed in the following Sūtra.

●

SŪTRA 32.

अर्पितानर्पितसिद्धेः ॥३२॥

ARPITĀNARPITA-SIDDHEḤ. (*32*)

(The determination of substances is done by giving prominence to their indestructible essence and giving a secondary place to their changeable conditions as it is necessary for their full consideration, because the permanent and the changeable aspects, though existing simultaneously, cannot be described simultaneously.

Similarly in other pairs of contradictory characteristics, one must receive primary and the other secondary consideration.

—J. L. Jaini)[318]

In Sthānāṅga Sūtra, a similar expression occurs :

अप्पितणप्पिते ।[319]

The author of *Sarvārthasiddhi* has explained this in the following words:

317. Quoted from the Speech of Mr. V. R. Gandhi on the subject before *The East India Association* (London), on May 21, 1900.

318. See *Tattvārtha Sūtra*, S.B.J. Series, Vol. II, p. 121.

319, *Sthānāṅga Sūtra*, 10'46.

अनेकान्तात्मकस्य वस्तुनः प्रयोजनवशाद् यस्य कस्यचिद्धर्मस्य विवक्षया प्रापितं प्राधान्यमर्पितमुपनीतमिति यावत् । तद्विपरीतमनर्पितम् । प्रयोजनाभावात्···।

Substances are endowed with an infinite number of attributes. When we describe a substance we can do so by adopting one point of view at a time so giving prominence to a few attributes. However it does not mean that other attributes are absent; what it means is that the missing attributes are of no purpose to us at that time.

For instance, we say that the universe is eternal from the point of view of the principles of conservation of mass and energy but it is not eternal from the viewpoint of entropy. Put in popular language, it means that the total amount of matter and energy in the Einstein's finite universe or in the finite Lokākāśa of Jain philosophy will ever remain constant and hence the universe is Nitya or permanent. From another point of view, the Second Law of Thermodynamics, the entropy of the universe is constantly changing. The various natural phenomena occurring spontaneously are tending towards equalization of temperature and pressure. According to this view everything is in a state of flux and a day would come when everyting would be at a stand-still. From this aspect of thought we may say that the universe is non-permanent, ever-changing or trasitory. These two viewpoints although giving apparently contradictory results, are perfectly sane.

But this simple truth of Jain metaphysics has proved a stumbling block to many. What to say of the ordinary intellects, even the great geniuses like Śankarācārya have failed to grasp its sense. For says he, "As thus the means of knowledge, the object of knowledge, the knowing subject, and the act of knowledge, are all alike indefinite, how can the Tirthankara teach with any claim to authority and how can His followers act on a doctrine the matter of which is altogether indeterminate?"

Or says Prof. S. K. Belvalkar, "The dogmatic part of Jain philosophy...is altogether irreconcilable when taken in conjunction with its dialectical part viz. the famous Syādvāda theory. As is well-known, this theory denies the possibility of any predication: S may be or may not be or may both be and not be P.

With such a purely negative or agnostic attitude one cannot afford to have any dogma."[320]

Let us therefore examine the proposition set forth by Prof. Belvalkar :

"S may be or may not be or may both be and not be P."

Strychnine is an alkaloid fatal to life. People have committed suicide by taking it internally. Nevertheless it possesses health-giving properties also and is prescribed by all medical men as a tonic. We therefore conclude that (1) Strychnine is a Poison from the viewpoint that it has killed several persons; (2) Strychnine is not a Poison from the viewpoint that it has restored health in several cases of anæmia.

Hence Strychnine is a Poison and not a Poison at the same time. Hence there is nothing absurd in the symbolical statement :

S may be, may not be, or may both be and not be P.

To the question what S is generally, i.e., in all cases, there can be no direct answer. We shall say it is indescribable (Avaktavyaṃ).

To quote another example from the domain of physics, light energy behaves as a wave-motion from the point of view of the phenomena of interference and diffraction; it behaves like a particle from the point of view of the phenomenon of photo-electricity; sometimes it behaves as both. To the question what light generally is, no direct answer can be given. The language fails to put the answer in one word. It was for this reason that Sir William Bragg humourously remarked that on Mondays, Wednesdays and Fridays we regard light as a wave and on Tuesdays, Thursdays and Saturdays we regard it is a particle. Put it in sober language it means that although the nature of light when viewed from different aspects is contradictory, nevertheless this gives us the complete picture of the thing.

This is exactly the Jain viewpoint. In order to describe a thing completely it must be reviewed from seven different aspects. While enumerating its various attributes only one aspect can be given prominence at one time. If by so doing we arrive at apparently contradictory results, there is nothing to be afraid of or surprised at it. A substance is a conglome-

320. Quoted from *Undercurrents of Jainism.*

ration of attributes, one may be prominent at one time and another at another.

The analogue, in modern science, of the theory of Syādvāda, is the Einstein's famous theory of Relativity. Just as the theory of Syādvāda was derided and ridiculed by the thinkers of non-Jain schools, so has been the fate of the theory of Relativity. Several mathematicians laughed and still laugh at the logic of relativity. Sydney A. Reeve, a veteran engineer, denounced the theory of Relativity in the 'Nation' saying:

"In plain English, the Einstein theory is arrant nonsense, as bodiless a chimera as ever got a great nation on the run."[321] The philosopher Guggenheimer has written a book in which he argues that Einstein has made a very silly basic error in logic.

One may call Einstein or the whole host of leading physicists mere fools but the fact remains that "Relativity is probably the farthest reach that the human mind has made into the unknown. ...It is commonly thought of as metaphysical...(but)...it is so mathematical that only a few hundred men in the world are competent to discuss it."[322] The difficult nature of Relativity is beautifully narrated in the following story given by Prof. Max. Born.

A friend of mine was once at a dinner-party and the lady next to him said: "Professor, do tell me in a few words what this theory of relativity really is." He replied: "Of course, I will—provided you will let me tell you this little story first. I was going for a walk with a French friend and we got thirsty. By and by we came to a farm and I said: 'Let's buy a glass of milk here'. 'What is milk?' 'Oh, you don't know what milk is? It is the white liquid that...' 'What is white?' 'White? You don't know what that is either? Well, the swan...' 'What is swan?' 'Swan the big bird with the bent neck.' 'What is bent?' 'Bent? Good Heavens, don't you know that? Here, look at my arm: when I put it so, it's bent!' 'Oh, that is bent, is it? Now I know what milk is'" After hearing the story the lady expressed that she is now no longer interested in Relativity.

However, leaving aside the mathematical aspect of the theory, its gist, in the words of Einstein himself, quoted by Mr. Bolton—an Englishman who won the Scientific American prize for the

321. Quoted from Ward's '*Exploring the Universe*', p. 257.
322. Ibid., p. 236.

best exposition of relativity, is as follows: "*Relativity as a whole is the theory of the statement of general physical laws* in forms common to all observers." The same writer continues to say "It is something of a puzzle why other writers of authority have not given this fact a more prominent place and stated it plainly and explicitly. It may have been because it seemed so obvious as not to require emphasis, but to the writer's mind the greater part of the mystery, which has surrounded the subject, has arisen through failure to grasp it. It was certainly so in his own case. When he realized it, the whole subject till then a hopeless jig-saw puzzle, seemed to arrange itself of its own accord."

He adds further on that "relativity describes...the fact that the old laws of physics were not universally true; they were true only in the limited sphere of inaccurate observation; they were merely relative. What the mathematicians have done is to derive formulas which shall be universally true for all conditions of space and matter and motion."

Let us examine the expression "general physical laws in forms common to all observers," and the terms 'true' and 'universally true' in greater detail.

On pages 29-30 we have quoted an experiment of a man in a lift, falling freely in space and dropping an apple. There we have seen that for the man in the lift the force of gravitation does not exist while for the man on the street it does. In other words, one thing is true with respect to one observer and not true with respect to the other, since they observe it under different conditions. The theory of relativity attempts to express natural phenomena in terms of such mathematical formulæ that they may hold universally, i.e., under all conditions. The mathematical language adopted by Einstein is analogous to the *avaktavyam* of the Syādvāda philosophy. For instance, Einstein's law of gravitation asserts that 'the ten principal co-efficients of curvature are zero in empty space.' Can this law be expressed in a language understandable? The plain answer is No. It is indescribable in common parlance, i.e.,...*avaktavya*. However when this law is analysed into its various aspects it gives all the results of common experience.

The *language of mathematics* is undoubtedly the most exact but the difficulty with it is that it cannot be *translated* into

spoken language. For instance, the portrait of a primitive man can be represented by the simple equation.—

$$y=4 \sin x+\sin 5x,$$

and the thoughtful intellectual profile demands an equation of over 100 terms, viz.—

$$y=A_1 \sin x+A_3 \sin 3x+A_5 \sin 5x+\ldots\ldots$$
$$A_{(2n-1)} \sin (2n-1)x+B_1 \cos x+B_3 \cos 3x+$$
$$B_5 \cos 5x+\ldots\ldots\ldots\ldots+B_{(2n-1)} \cos (2n-1)x,$$

where n should be greater than 50.

Other additional equations could be given to express the eye, the lips and the wrinkles.[323]

The question naturally arises, what is the necessity of employing such a language for the expression of natural laws. The answer is : Otherwise the same law reads quite differently when studied by different observers under different conditions or from different points of view. Now what is true of a particular law of Nature is also true of all statements in general. We have already discussed the statement : 'Strychnine is Poison 'from different aspects and seen that we arrive at results apparently contradictory.

The case of a stationary conductor charged with electricity situated on the surface of the earth has been dealt with on page VIII of the Prologue. There we have seen that there is no magnetic field round the conductor from the point of view of a person situated on the earth but there is a magnetic field round the same conductor from the point of view of a celestial observer. To the direct question : Is there a magnetic field round the conductor or is there none ? no answei can be given. How can the same body both give and not give a magnetic field at the same time ? In the language of Jain *syādvāda* it is indescribable (*avaktavyam*). According to Einstein, "We can only know the relative truth, the Absolute truth is known only to the Universal observer."

The age-old controversy whether the earth moves round a stationary sun or the sun moves round a stationary earth was beautifully decided by the theory of relativity. Both may be

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323. Quoted from F.M. Denton's '*Relativity and Commonsense*'.

right or both may be wrong depending upon the viewpoint which we adopt. We have no means at our disposal to decide between the counter statements or to determine the real state of things. The only thing which we can say is that the motion between the earth and the sun is relative[324] and 'in certain cases it is more convenient to relate the motion of heavenly bodies to the solar than to the terrestrial system'.

Referring to the relativity of direction Prof. Eddington writes : "A more familiar example of a relative quantity is 'direction' of an object. There is a direction of Cambridge relative to Edinburgh and another direction relative to London,

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324. It is interesting to give a complete picture of the relative motions between the various components of the universe. Beginning with the smallest, the electrons are rushing with enormous speeds round the nucleus inside an atom, the atoms are vibrating inside the molecules, the molecules are executing harmonic motion even in solid bodies. The atoms and molecules compose the huge body of the Earth, the latter taking part in the Gopi dance of the solar system. In the solar system the Sun is the Krishna surrounded by planets, the Gopis, the latter whirling round the former. Even this pattern taken as a whole is not confined to one locality in space —the *Rāsa-maṇḍala* (the dance party) is constantly shifting towards a fixed point in the heavens, viz., Herculis with a velocity of 4,22,000 miles per day. With regard to the nature of the dance it may be noted that not only are the Gopis dancing round the Sun Krishna but each is whirling round its own axis including the Sun himself. Then there are satellites or moons (attendants) attached to each Gopi. These are paying homage to their respective Gopis by going round them.

Now this *Rāsa-maṇḍala* or our solar system forms but a tiny member of our Galaxy called the Milky Way. The Milky Way, three hundred thousand light-years in diameter and ten thousand light-years in thickness and having a population of over 40 billion stars is also revolving about an axis directed towards a point in the Sagittarius star cloud. It takes 200,000,000 years to complete one revolution.

In the words of Prof. A.C. Banerji 'our galactic' system is rotating like a cart wheel (चक्रनेमिक्रमेण) with this difference that the inner part of the wheel rotates more rapidly than the outer part. Our sun is about 37,000 light-years away from the hub of this gigantic wheel which lies in a massive star cloud in the constellations of Ophiuchus and Scorpio......the sun and the stars in its neighbourhood attain a speed of 200 miles per second due to the rotation of the galaxy alone." And what is our galaxy after all—one of a swarm of countless similar galaxies filling the whole universe. This is the complete picture of the relative motions of the members of our galatic system as known so far. The absolute motions it is impossible to determine.

and so on. It never occurs to us to think of this as a discrepancy or to suppose that there must be some direction of Cambridge (at present undiscoverable) which is absolute. The idea that there must be an absolute distance between two points contains the same kind of fallacy. There is, of course, a difference of detail, the relative direction abovementioned is relative to a particular position of the observer, whereas the relative distance is relative to a particular velocity of the observer. We can change position freely and so introduce large changes of relative direction but we cannot change velocity appreciably—the 300 miles an hour attainable by our fastest devices being too insignificant to count. Consequently relativity of distance is not a matter of common experience as the relativity of direction is. That is why we have unfortunately a rooted impression in our minds that distance ought to be absolute."[325]

We thus see that even such an obvious statement like 'The length of this table is 5 ft.' is a relative statement. It may or may not be true or may both be and not be true depending upon the state of the observer. It may be true with respect to a stationary observer, may not be true with respect to a second who is in relative motion with respect to the first and carrying the measuring rod, for, as has been proved by Einstein a moving rod contracts[326] along the line of its motion.

Referring to this contraction, Professor Eddington raises the question "Is it really true that a moving rod becomes shortened in the direction of its motion ?" and he then adds : "It is not easy to give a plain answer. I think we often draw a distinction between what is true and what is really true. A statement which does not profess to deal with anything except appearances may be true ; a statement which is not only true but deals with the realities beneath the appearances is *really true*."[327]

Professor Eddington continues : "You receive a balance sheet from a public company and observe that the assets amount to such and such a figure. Is this true ? Certainly ; it

325. *The Nature of The Physical World*, p. 26.

326. The contraction, however, is extremely small. For a speed of 19 miles per second contraction is 1 part in 200,000,000 or 2½ inches in a length of 8,000 miles.

327. *The Nature of the Physical World*, p. 33.

is certified by a chartered accountant. But is it really true? Many questions arise; the real values of items are often very different from those which figure in the balance sheet. I am not especially referring to fraudulent companies. There is a blessed phrase 'hidden reserves'; and, generally speaking, the more respectable the company the more widely does its balance sheet deviate from reality."

In the foot-note on page VIII of the Prologue we have pointed out that 'true' and 'really true' refer to *vyavahāra Naya* and *niścaya Naya* of Jain logic. These two Nayas (points of view) are defined as follows:

तेनेदं भाष्यसंदिष्टं गृहीतव्यं विनिश्चयम् ।
तत्वार्थंनिश्चयो वक्ति व्यवहारो जनोदितम् ॥[328]

(*niścaya* point of view narrates the reality behind appearances and vyavahāra narrates things from a popular point of view.)

Mr. S. C. Ghoshal, M.A., B.L., says: "Vyavahāra Naya is the ordinary or commonsense point of view in which we speak everyday about the things of this world. But Niścaya Naya is the realistic point of view, which attempts an accurate description of realities which are overlooked in our everyday parlance. For example, we ordinarily say 'a jar of honey' but to be accurate we must say 'a jar of clay or some other substance containing honey.'[329]

Consider another statement: "The weight of this body is 194 lbs." Is this absolutely correct? It may or may not be correct, for a weight of 194 lbs. at the equator weighs 195 lbs. at the poles. Apart from the position of the observer it also depends upon the state of the body, whether it is at rest or in motion.[330] It has been proved by Einstein and verified by several experiments that the mass of a body is variable and increases with the velocity of the body. Hence the statement

328. *Dravyānuyoga Tarkaṇā*, 823.

329. See *Dravya Saṁgraha*, S.B.J. Series, Vol. I, p. 7.

330. "Take body at rest. It has a definite mass. This is called the rest mass of the body. Assume now that this body is set in extremely rapid motion. ...Will the mass of the body change? The classical physics answers this question in the negative... The theory of relativity predicts not only that mass increases with velocity but also in what way mass depends upon velocity."

—*The World in Modern Science*, p. 80-81.

under consideration is not true from all points of view. It will have different apparently contradictory answers when considered from different aspects.

In connection with the relativity of Time, Eddington examines the following statement : "If two people meet twice they must have lived the same time between the two meetings, even if one of them has travelled to a distant part of the universe and back in the interim". "If the question is pressed", he says, "most people would answer impatiently that of course the statement is true" but "it is well known both from theory and experiment that the mass or inertia of matter increases when the velocity increases. The retardation is a natural consequence of the greater inertia. Thus so far as bodily processes are concerned the fast moving traveller lives more slowly. His cycle of digestion and fatigue ; the rate of muscular response to stimulus ; the development of his body from youth to age ; the material processes in his brain which must more or less keep step with the passage of thoughts and emotions ; the watch which ticks in his waistcoat pocket ; all these must be slowed down in the same ratio. If the speed of travel is very great we may find that, whilst the stay-at-home individual has aged 70 years, the traveller has aged 1 year. He has only found appetite for 365 breakfasts, lunches, etc., his intellect, clogged by a slow-moving brain, has only traversed the amount of thought appropriate to one year of terrestrial life. His watch, which gives a more accurate and scientific reckoning, confirms this......the two men have not *lived* the same time between the two meetings."

Thus we see that the statement "If two people meet twice they must have lived the same time between the two meetings" is true from one point of view and not from another. It all depends upon whether both of them have been stay-at-home or one has travelled to a distant part of the universe and then came back in the interim.

It is on the relativity of length, mass and time that the magnificent structure of the Theory of Relativity has been raised and the miraculous results obtained as quoted on page VI f.n. of the Prologue. To summarise what we have said in the foregoing pages, even the commonplace statements, viz., the length of this table is 5 ft., the mass of this body is 174 lbs. or the age of

a certain person is 70 years, are relative statements, i.e., they may or may not be true depending upon the point of view.

As the modern theory of relativity has worked wonders in the domain of physics, so did *syādvāda* or *anekāntavāda* (the philosophy of stand-points) produce revolution in metaphysical thought. It served as the key to unlock the doors of wisdom and the sole means of establishing uniformity amidst diversity of views. It aims to bring within a single fold the apparently divergent systems of philosophies by interpreting their truths from various stand-points. In the words of a great American thinker "It promises to reconcile all conflicting schools, not by inducing any of them necessarily to abandon their 'favourite' stand-points but by proving to them that the stand-points of all others are alike tenable or at least they are representative of some aspect of truth which under some modification needs to be represented and that the integrity of truth consists in this very variety of aspects, within the rational unity of an all-comprehensive and ramifying principle."[331] Jainism points out that the claim of different philosophies to represent the truth, the whole truth and nothing but truth is false. Each of them represents a partial truth. For instance, the old conflict between Dualism and Monism of Vedānta is pacified by Jainism saying that God is one from the point of view of Essence, from the view-point of being Perfect, Pure Statehood of All-knowing, All-seeing, All-powerful, All-happy, etc., but from the point of view of manifestation. He is not only many but infinite. There is nothing vague or indefinite in such conceptions, for they represent a synthesis of conclusions drawn from different stand-points, each conclusion being quite definite and clear in itself.

The same is the case with the laws of Einsteinian relativity. They embody as a part the laws previously deduced by Newton —the latter represent only one aspect of truth. Newton's laws do not hold when we consider natural phenomena on a microscopic or a macroscopic scale.

This establishes the great importance of the Sūtra under consideration : "अर्पितानर्पितसिद्धेः" ।

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331. See *Nyāya Karṇikā*, pp. 24-25.

SŪTRA 33.

स्निग्धरूक्षत्वाद्बन्धः ॥३३॥

SNIGDHA-RŪKṢATVĀDBANDHAḤ (33)

(पुद्गलानां स्निग्धरूक्षत्वाद् बन्धो भवति ।)

The Pudgalas unite by virtue of the properties of Snigdha and Rūkṣa associated with them.

Also in Śwetāmbara granthas we have:—

"बंधपापरिणामे···दुविहे पण्णत्ते, णिद्धबंधणपरिणामे लुक्खबंधण-परिणामे य..."[332]

As mentioned incidentally on page 145 these terms[333] *snigdha* and *rūkṣa* appear to have been arbitrarily used as the terms positive and negative have been used by modern electricians to denote the two kinds of electricity. This is further explained in gāthā 615 of *Gommaṭasāra* (*Jīvakānḍa*) :

णिद्धस्स णिद्धेण दुराहिएण लुक्खस्स लुक्खेण दुराहिएण ।
णिद्धस्स लुक्खेण हवेज्ज बंधो जहण्णवज्जे विसमे समे वा ।

A positive elementary particle combines with another similar particle differing in energy level by two units : Also a negative elementary particle combines with another negative elementary particle differing again in energy level by two units.

A positive particle can also unite with a negative particle and vice versa. Particles at the lowest energy level do not unite. The union of the various particles of different energy lavels may form an odd or an even series,—3, 5, 7, 9, etc., or 2, 4, 6, 8, etc.

A few examples are given below from modern science to

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332. *Prajñāpanā Sūtra*, 13·948.

333. One is likely to question as to what led us to identify Snigdha and Rūkṣa qualities of Pudgala with positive and negative electrifications. In support of our interpretation we quote the following words from *Sarvārtha Siddhi* (on Sūtra 5·24).

"......स्निग्धरूक्षत्वगुणनिमित्तो विद्युत्..."

(Lightning discharge in clouds is produced by the qualities of Snigdha and Rūkṣa i.e., due to the development of positive and negative charges.)

illustrate these combinations :

The heavy electron, referred to on page 87 f.n. has been formed by the union of electrons, i.e., negative elementary particles of matter. If we call negative as Rūkṣa, this is a case of Rūkṣa combining with Rūkṣa.

In the '*Science and Culture*' for February 1938 we read that Prof. Eddington "from his theory, has predicted the existence of negatrons" (negative protons) i.e., particles as heavy as the protons but composed of negative particles or negative electric charges. We are pleased to state that such a particle has been *discovered* and it is an example of Rūkṣa particles combining with Rūkṣa.

The Snigdha combining with Snigdha is illustrated in the formation of protons. Positron is a snigdha elementary particle whereas the proton is a much bigger particle of the same kind. We venture to suggest that a proton has been formed by a close packing of elementary positive particles just as the close packing of protons gives rise to nuclear matter.[334] (see pages 12-13 ante.)

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334. Further discoveries of this kind have been announced in the 'Nature', April 16 and May 7, 1938.

Williams and Pickup have obtained results which tend to confirm the existence of particles of mass intermediate between that of the electron and the proton in the cosmic ray streams. Photographs showed the presence of particles of mass about 200 times that of the electron, carrying in some cases positive and in others negative charges. One photograph indicated the presence of a particle of mass greater than 430 times that of the electron. Street and Stevenson (1937) obtained results which could be explained by the existence of a negative particle with mass about 130 times that of the electron. Nishina, Takeuchi, and Ishimiya (1937) obtained indications of the particles of both signs having masses about 1/7 to 1/10 of that of the proton, while Ruhlig and Crane (1938) considered that there were particles of mass (120±30) times that of the electron. This leaves no doubt about the combinations between Snigdha and Rūkṣa particles to form similar particles of greater mass.

Drs. W. Kellerman, G. Brooke and J. Baruch of Leeds University, (England), have discovered heavy protons of mass 40 to 70 times the normal mass in the cosmic ray streams.

(*The Science Reporter*, March 1974)

The formation of these heavy protons, called 'W' particles, has been explained by saying that the individual protons with high interaction are capable of passing through each other for an instant and merge into one particle.

In all such cases—the union of electrons to form a heavy electron or a negative proton, the union of positrons to form protons and the union of protons to form nuclear matter—the point is not clear as to why similar kinds of elementary particles should combine at all, since ordinarily two similar electric charges do not attract each other but repel.

This is explained by saying that the forces which keep the protons and neutrons bound together inside the nuclei of atoms change their character when the distance between them is about 10^{-13} Cm. or less. A similar case in gravitation has been pointed out on page 95.

The structure of the neutron shows that it is an example of a Snigdha particle combining with a Rūkṣa particle—a proton combining with an electron in close union.

The nuclei of modern atoms are also an aggregation of protons, neutrons and Mesons and therefore serve as examples of Snigdha combining with Rūkṣa. The structure of an atom, as explained in pages 9-12, points in the same direction. In the formation of molecules from atoms we again see the union of Snigdha and Rūkṣa atoms. In Fig. 1, we have shown a crystal of common salt (sodium chlorida). It is composed of atoms of sodium and chlorine. When it is dissolved into water it dissociates into positive (*snigdha*) ions of sodium and negative (Rūkṣa) ions of chlorine. The equation is

$$NaCl = Na^{\cdot} + Cl'$$

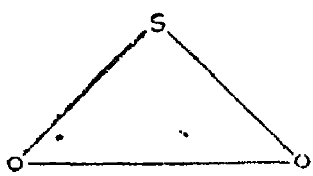
or in the case of Copper Sulphate (Nılā Tutiyā)

$$CuSO_4 = Cu^{\cdot\cdot} + SO_4''$$

(Dots are used at the top to denote Snigdha atoms and dashes to denote Rūkṣa.)

Referring again ta Gāthā 615 of the Gommatasāra quoted on page 160 ante we see that the necessary condition for union is that the combining particles or atoms should differ in energy level by two units. These units it is difficult to identify but it appears to be a sort of Exclusion Principle, and might, if properly interpreted, to be used to explain the periodicity of the systems of the electrons in atoms, as does the Pauli's Exclusion Principle. There is no doubt, however, that there are various kinds of union differing in degrees of strength. "A question", said Sir Venkata Raman once, "of fundamental importance both to the physicist and to the chemist is, why do

atoms combine to form molecules?" The learned professor then continues to say "we are not yet in a position to give a complete answer to this question. The facts of chemistry, however, compel us to recognize that chemical combination may be of different kinds. As an example of one type of chemical combination, we may instance the case of common salt. The elements sodium and chlorine when allowed to come in contact combine with explosive violence to form salt. Nevertheless when we dissolve common salt in water, there are excellent grounds for believing that the substance breaks up again into electrically charged atoms of sodium and chlorine respectively. We have quite a different type of combination when two atoms of the same element as, for example, oxygen, combine to form a molecule of the element.[335] When oxygen dissolves in water the molecule does not dissociate again into separate atoms.[336] The Raman Effect[337] enables us not only to distinguish between the different types of chemical bindings between atoms but also to go much further, and measure quantitatively the strength of the binding forces between the constituent atoms in a molecule." For instance, measurements of Raman Effect, into the details of which we need not go, show that the structure of a molecule of carbon-di-oxide gas is of the form O=C=O, oxygen atoms are bound to the carbon atoms by double bonds, whereas the structure of a molecule of sulphur-di-oxide gas is of the triangular form as



where S stands for an atom of sulphur and O for an atom of

335. Sodium atoms combining with chlorine atoms is a case of Snigdha uniting with Rūkṣa, whereas two oxygen atoms combining to form a molecule of oxygen is a case of Rūkṣa uniting with Rūkṣa.

336. It shows that in this case the bond between oxygen atoms is much stronger than that between sodium and chlorine atoms in a molecule of common salt.

337. Sir C. V. Raman was awarded the Nobel Prize for the discovery of this effect.

oxygen. Notice further that the bonds are single in this case.

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SŪTRA 34.

न जघन्यगुणानाम् ॥३४॥

NA JAGHANYA-GUṆĀNĀṂ (34)

(न जघन्यगुणानाम् परमाणूनां बन्धो भवति ।)

(The ultimate elementary particles at the lowest energy level do not unite at all.)

In other words, we should expect to find electrons and positrons in perfectly free state as well and so it is. We quote the following from *The Advanced Text-book of Magnetism and Electricity*:

"Conduction of electricity in electrolytes and in gases is effected by positively and negatively charged carriers called ions. In liquids the ions are free charged atoms or groups of atoms ; in gases the negative ion is an electron loaded up by having attached to it one or more neutral atoms (at low pressures the electron throws off its attendant neutral atoms and travels alone), whilst the positive ion is an atom which has lost one electron. The conduction of electricity in solids is also effected by carriers *but the latter in this case consist solely of free electrons.*"[338]

Further in the same book the author adds that these free electrons in metals are not only responsible for the conduction of electricity but that "in the light of modern work there is every reason to believe that the electrons in the metals are the essential agents in the heat transference"[339] also.

Also the positrons have been found to occur in a free state in Nature. In fact their first discovery was made by Anderson in a stream of cosmic rays.

The Jain conception of different energy levels associated with the elementary particles of matter, viz., electrons and

338. *The Advanced Text Book of Magnetism and Electricity*, Vol. II by R. W. Hutchinson, p. 481.

339. Ibid., p. 485.

positrons is confirmed from many sources. Referring to Pauli's exclusion principle Prof. Born says "An electron gas is supposed to exist in the interior of metals and to account for their high conductivity. According to our former principles, we should have to give each of the electrons a name, Edward, John, George and so on. ......The extremely satisfactory discovery was made that the new Fermi-Dirac statistics applied to the electrons in metals gives much better results than the older theory."[340] As mentioned on page 99 Fermi-Dirac statistics gives us a means distinguishing between individual electrons having different energies.

Not only in the electrons but in the individual atoms also there is some distinction which certain phenomena seem to indicate but which science has not been able to elucidate so far. For instance, referring to the phenomenon of radioactivity, Prof. Max Born further says, ' We may cherish the opinion that there must ultimately be some inner reason for the fact that one atom lives only a few seconds and its apparently identical neighbour many years ; but no one has yet succeeded in putting his finger on the cause."[341] This statement clearly shows that atoms do differ in some intrinsic property which Jain writers have been given the designation 'the degree of *snigdhatva* and *rūkṣatva*'.

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SŪTRA 35.

गुणसाम्ये सदृशानाम् ॥३५॥

GUṆA-SĀMYE SADṚŚĀNĀM (35)

(न गुणसाम्ये स्निग्धरूक्षत्वानाम् सदृशानाम् परमाणूनाम् बन्धो भवति ।)

Although the reading of this Sūtra is exactly identical in Digambara and Śwetāmbara texts, the interpretation is not the same. According to the Śwetāmbaras the interpretation is as

340. *The Restless Universe*, p. 214.
341. Ibid., p. 238.

follows :

Paramāṇus (the ultimate elementary particles of matter) with equal degrees of *snigdhatva* or *rūkṣatva* and of the same kind cannot unite with a *paramāṇu* of their own kind. In other words, an electron would not combine with another electron or a positron with a positron if both the particles are at the same energy level but an electron can unite with a positron or vice versa under the same conditions.

The Digambara interpretation is embodied in the following commentary by Ācārya Vidyānandi in *Ślokavārtika*, Sūtra 35 :

नन्वेवं विसदृशानां गुणसाम्ये बन्धप्रतिषेधो न स्यादिति न मन्तव्यम्, सदृशग्रहणस्य विसदृशव्यवच्छेदार्थत्वाभावात् सदृशाना-मेवेत्यवधारणानाश्रयणात् ।

(It is not correct to interpret the Sūtra saying that the elementary particles of opposite kind can unite even if the degrees of Snigdhatva or Rūkṣatva are equal. This is not corroborated anywhere.)

Thus the main difference in the interpretation lies in the fact that while Digambars deny the possibility of union for all combinations of particles at the same energy level while the Swetāmbaras recognize such a possibility if the union is between particles of opposite kind. According to Digambaras, the inevitable condition for union amongst elementary particles is expressed in the following Sūtra.

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SŪTRA 36.

द्व्यधिकादिगुणानां तु ॥३६॥

DVYADHIKĀDI-GUṆĀNĀṂ TU (36)

According to Digambaras this is equivalent to :

(द्वि-अधिक-आदिगुणानाम् सदृशानाम्-विसदृशानाम् परमाणूनां परस्परेण बन्धस्तु भवति ।)

A positive or a negative elementary particle combines with another of a similar or a dissimilar type if they differ in their

degrees of *snigdhatva* or *rūkṣatva* by two units.

The Śwetāmbaras do not recognize this as a necessary stipulation for the union of the particles of dissimiler types.

It is difficult to interpret this Sūtra strictly on the lines of modern science for certain reasons. We have pointed out before that the heavy electron, the mesons, or the negative proton can reasonably be looked upon as its being formed by the union of the ultimate particles, the electrons ; similarly a proton can be thought as made up of 1,850 positrons. In fact on pages 161 ante we have cited these as the examples of 'Rūkṣa combining with Rūkṣa and Snigdha combining with Snigdha particles. These operations of union appear to be carried out either in the deep interiors of the nuclei of the atoms or in certain secret corners of the interstellar space where physical conditions are favourable for such a union. Therefore it has not[342] been possible to study the laws which govern such unions.

Let us, however, study the neutron of modern physics. It is formed by a very close union of a Snigdha particle and a Rūkṣa, the proton and the electron. In the hydrogen atom the electron goes round the proton forming a planetary system with dimensions of the order a hundred-millionth of a centimetre. If the radius of the electronic orbit is made ten thousand times smaller, we arrive at the neutron model. The mass of the neutron is, therefore slightly greater than the mass of the proton.

Further if we glance over the table of atomic weights of various isotopes[343] given by Infeld,[344] we are struck by the round numbers differing by unity. We reproduce below a

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342. On p. 54 of *The New Chemistry* by Andrade the number of protons in the nucleus of an atom have been plotted against the corresponding neutrons A glance at the figure shows that 'there is a valley of stability running across the diagram......Combinations well away from the valley are impossible'. Says the author of the book, "One of the problems of new chemistry is to find convincing reasons for this. In other words, what are the rules which will enable us to predict which combinations of protons and neutrons are stable, which unstable and which impossible? So far they have not been discovered."

343. Isotopes are atoms of different weights but of identical chemical properties.

344. *Science in Modern World*, p. 155.

part of the table.

Element	*Atomic weights of isotopes.*
Neon	20-22-21
Magnesium	24-25-26
Silicon	28-29-30
Sulphur	32-34-33
Zinc	64-66-68-67-65-70
Gallium	69-71

Note :—In the above table the isotopes are arranged in the descending order of frequency of occurrence. 21 comes after 22 ; it only means that the atoms of weight 22 are more abundant than the atoms of weight 21.

This seems to support the Jain view that atoms have been formed by a definite law of union, a difference of two degrees of Snigdhatva or Rūkṣatva producing a diffference of weight by unity.

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SŪTRA 37.

बन्धेऽधिकौ पारिणामिकौ च ॥३७॥

BANDHEDHIKAU PĀRIṆĀMIKAU CA. (37)

(बन्धे अधिकगुणौ पुद्गलौ परमाणू वा स्कंधौ पारिणामिकौ च भवतः ।)

(In the process of union an elementary particle, an atom or a molecule with a higher degree of Snigdhatva or Rūkṣatva absorbs the one with a lower degree into itself.)

The same view is expressed in *Gommaṭa-Sāra.*

णिद्धिदरगुणा अहिया हीणं परिणामयंति बंधम्मि ।
संखेज्जासंखेज्जाणंतपदेसाण खंधाणं ॥[345]

(In molecules of finite, infinite and transfinite atoms, the atoms with greater degrees of Snigdhatva or Rūkṣatva when uniting alter the atoms of lesser degree to their own kind.)

345. *Gommaṭa Sāra,* (Jīvakāṇḍa) 619.

In Śwetāmbara text the Sūtra reads as follows :

बन्धे समाधिकौ पारिणामिकौ

(बन्धे सति समगुणस्य समगुणः परिणामको भवति, अधिकगुणो हीनस्तिये ।[346])

As referred to on page 167 ante the Śwetāmbara text admits the possibility of union between dissimilar particles or atoms with equal degrees of Snigdhatva and Rūkṣatva the present Sūtra is also modified in conformity with the previous view and it says that the union between dissimilar particles of equal degrees of Snigdhatva and Rūkṣatva will produce a neutral particle or an atom whereas in the union of an atom of a higher degree with one of a lower degree, the character of the latter will be converted into that of the former.

In the formation of the neutron (see p. 73 ante there appears to be a compromise between the Digambara and the Swetāmbara views. The binding energies of the proton and the electron are very much different but the resulting atom is neutral (Samaguṇaḥ).

"Each atom carries into its combination two things : first its own proper energy ; and, second, the faculty of expending this energy in its own way, in attaching other atoms to itself, not indiscriminately, but in definite atoms and in definite numbers."—C. A. Wurtz (1869). The atom-fixing power of an element has been termed valency by the modern chemist. A. S. Couper (1858) called it the *affinity of degree*. For instance, the valency of an atom of nitrogen is one in N_2O, two in NO, three in N_2O_3, four in N_2O_4, and five in N_2O_5. The valency of an atom of chlorine is one in $H\,Cl$, four in ClO_2 and seven in Cl_2O_7.

"The differences in the valency of different elements have been explained by supposing that an atom of an *n*-valent element is compounded of *n*-units, each of which is capable of attracting one other unit. A constant quantity of one element, said E. Erlenmeyer (1862), never binds itself to more or to less than a constant quantity of another element—this he called the *law of affinivalencies*......A. W. Hofmann (1865) called, the same, the minimum atom-binding quantities of an element." the Jains connoted this idea by the difference in the degrees of *guṇas*.

346. *Tattvārtha Sūtra*, Bhāṣya on Sūtra 5·37..

It should be noted however that except in the case of ionized atoms (Skandhadeśa) (see p. 139 ante) the resulting molecule formed by the union of atoms is (Samaguṇī) neutral, neither Snigdha nor Rūkṣa. However in the process of ionisation, explained on page 142, it is easy to see how an electron by attaching itself to a neutral atom changes the latter into its own kind—negative ion.

How a Snigdha particle is changed to Rūkṣa or vice versa is seen very well in the example given above and in many others. Chlorine atom in HCl (hydrochloric acid) is Rūkṣa while the same atom in Cl_2O_7 is Snigdha ; in the modern language they are called respectively electro-negative and electro-positive. Hydrogen atom in HCl is electro-positive. While the same atom in sodium or potassium hydride (Na H or KH) is electro-negative. Many more such examples can be cited. Thus the truth enunciated in the Sūtra is established.

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SŪTRA 38.

गुणपर्ययवद् द्रव्यम् ॥३८॥

GUṆA-PARYĀYAVAD DRAVYAM (38)

A substance is always associated with certain intrinsic and inalienable qualities called Guṇas and it constantly changes its modes of existence called *paryāyas* (modifications).

COMMENTARY

This universe of ours is constituted by six fundamental realities—Spirit (soul), Matter including energy, Space, Time and the media necessary for the operation of dynamic and static forces, the last two in the language of science being the luminiferous æther and the fields of force—gravitational and electromagnetic. But to define reality has alway been a stumbling block with philosophers old and new.

The Jain philosophers have given a very satisfactory definition of 'reality' in Sūtras 29 and 30 and the same subject has been more fully discussed in pages 51-54 and 77-80.

In the present Sūtra a substance has been defined in an

alternate manner, since substances are many from another point of view. It says that a substance always possesses attributes and undergoes modifications. For instance, Matter possesses properties of touch, taste and smell while the soul substance is characterised by consciousness. The relation between the substance and its qualities, has, however, given rise to two different schools. "One always emphasises the permanent basis as the real and the other the changing qualities. The former condemns change as mere appearance or Māyā, whereas the latter condemns the permanent substance as a mere figment of imagination. The former school generally ends in agnosticism and maintains that real is unkown and unknowable. The latter generally ends in scepticism and sweeps away in a flood of doubt the fundamental concepts of life and world, of morality and religion. In India we have Advaita Vedānta as an example of the former and Budhhism of the latter. In the West, the philosophers, like Locke and Kant may be mentioned as representatives of the former school and Hume may be taken as a type of the latter."[347]

Even the great modern thinkers and scientists like Eddington have found it impossible to frame a suitable definition of a 'substance'. Referring to the present world, he says, "How shall I describe it ? It has extension ; it is comparatively permanent ; it is coloured ; above all it is substantial. By substantial I do not merely mean that it is constituted of 'Substance' and by that word I am trying to convey to you some conception of its intrinsic nature. It is a *thing* ; not like space, which is a mere negation ;[348] nor like time, which is—Heaven knows what ! But that will not help you to my meaning because it is the distinctive characteristic of a 'thing' to have this substantiality, and I do not think substantiality can be described better than by saying that it is the kind of nature exemplified by an ordinary table. And so we go round in circles."

347. A Philosophical Introduction to *Pañcāstikāya Sāra*, S.B.J. Series. Vol. III, p. XXX.

348. Space is not a negation but a real substance. This fact has been established in pages 109-111. The nature of time as a reality has been explained in pages 116-121 and more has been said in the following Sūtra No. 39.

SŪTRA 39.

कालश्च[349] ॥३९॥

KĀLAŚCA (39)

(Time is also a substance.)

In the Śwetāmbara text the reading is :

"कालश्चेत्येके" (काल: च इति एके) ।
(भाष्यम्: एके त्वाचार्य्या व्याचक्षते कालोऽपि द्रव्यमिति।)

(According to some Ācāryas, Time is also a substance.)

Ācārya Siddhasenagaṇi regards Time as a modification of Jīva and Ajīva (soul and matter). In the Śwetāmbara work *Jīvābhigama* the same view is expressed but in *Bhagavatī Sūtra* and other standard works Time has been regarded as a separate reality. Ācārya Umāswāmi, the author of the present work, having first firmly established the characteristics of a reality in Sūtras 29, 30 and 38 finds that all the characteristics mentioned in these Sūtras are inherent in the entity called the Time and therefore now at this late stage he mentions Time to be a reality like the other five realities mentioned before, thus making the total number of fundamental realities as six.

We now proceed to investigate the nature of Time.

As described in pages118-120, Time is divided into two categories—Absolute and and Apparent, *de jure* and *de fecto*. The former is made up of Kālāṇus (grains or quanta of Time.)[350] See Gāthā below :

लोयायासपदेसे इक्किक्के जे ठिया हु इक्किक्का ।
रयणाणं रासी इव ते कालाणू असंखदव्वाणि ॥[351]

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349. Read this Sūtra in conjunction with Sūtra 22.

350. Grains or quanta of Time, cells of space or space-points and ultimate indivisible particles of matter,—Kālāṇus, Pradeśas and the Paramāṇus are the distinctive conceptions of Jain thought confirmed by the researches of today.

351. *Dravya-Samgraha*, 22.

Or

"एकैकवृत्त्या प्रत्येकमणवस्तस्य निष्क्रियाः ।
लोकाकाश-प्रदेशेषु रत्नराशिरिव स्थिताः ॥[352]

Or

"लोकाकाशप्रदेशे ये ह्येकैका अणवः स्थिताः ।
भिन्न-भिन्नप्रदेशस्था रत्नानामिव राशयः ॥[353]

(Tr.—Innumerable grains of Time reside, one in each space-point of the finite universe (Lokākāśa), like heaps of jewels.)

In other words, the Time consists of units which never mix with one another but are always separate. The whole universe (excluding Aloka—the pure space beyond finite universe) is full of these grains of Time; no part of the space within it is devoid of them. These grains are invisible, without form and inactive, i.e., in a static condition and countless in number. They have been compared with jewels to signify that they never mix or coalesce. This characteristic differentiates Time from the other five substances; for, while the former consists of separate particles, the latter are collections of indivisible and inseparable parts. In the technical language of the Jains.

कालस्स दु णत्थि कायत्तं ।[354]

Time has no spatiality or extensive magnitude. Extension is of two kinds, longitudinal Extension and multi-dimensional Extension called respectively ऊर्ध्वप्रचय (Ūrdhva-pracaya) and तिर्यक्-प्रचय (Tiryak-pracaya). The existence of the grains of time can be represented by a mono-dimensional mathematical series and hence said to have only the longitudinal Extension. For this reason Time is not included in the list of Astikāyas. (For definition of Astikāya see p. 3 ante.) The other five substances, Soul, Matter, Space and Media of motion and rest,—require a series where each term of the first series is an item in the second. The latter is called a two dimensional series and corresponds to the surface Extension or Triyak Pracaya.

The distinction between apparent and absolute or real time is given in Gāthā 107 of *Pañcāstikāya Sāra* quoted on page 118. The former has a beginning and an end while the latter is

352. *Tattvārtha Sāra*, 3·44.
353. *Vardhamāna-Purāṇa*, 16·35.
354. *Pañcāstikāya Sāra*, 102.

eternal. The scientists also suspect that there is a real time behind the apparent time. Says Prof. Eddington : "Whatever may be time *de jure*. The Astronomer Royal's time is time *de facto*...... You may be aware that it is revealed to us in Einstein's theory that time and space are mixed up in a rather strange way. This is a great stumbling block to the beginner."[355] The mixing of space and time is well expressed in the Gāthās quoted above and in the following quotation from the *Sarvārtha Siddhi* :

लोकाकाशस्य यावन्तः प्रदेशाः तावन्तः कालाणवो निष्क्रिया एकैकाकाशप्रदेशे एकैकवृत्त्या लोकं व्याप्य व्यवस्थिताः ।

(As many cells of space there are, so many Kālāṇus or grains of time are located lying static, one in each cell, permeating every iota of Loka (the finite universe).

"One startling conclusion from Einstein's theory is that both space and time vanish away into nothing if there be no matter. We cannot conceive of space and time without matter. It is matter in which originate space and time and our universe of perception."[356] So is the conclusion of Jain thinkers : In the infinite pure space extending beyond Loka, no other substance exists but space ; there is no matter and hence no grains of time. The resemblance is striking. It is also true that human mind would fail to perceive space if there were no matter in it but since space is an independent substance, there is nothing to deny the possibility of its existence beyound Loka and as remarked in previous pages this idea of Loka and Aloka has solved a number of difficulties.

The *akāyatva* (non-spatiality) of time is admitted by Eddington when he says : "I shall use the phrase time's arrow to express this *one way property of time* which has no analogue in space. It is a singularly interesting property from a philosophical stand-point."[357]

The Kālāṇus represent the physical time analogous to the 'world-wide instants', as Eddington chooses to call them, exis-

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355. *The Nature of the Physical World*, p. 36.

356. *The Proceedings of Physics Seminar*, University of Allahabad, July 1925, p. 37 ; Article on '*Relativity*' by Dr. N.R. Sen.

357. *The Nature of the Physical World*, p. 69.

ting in the four-dimensional world.[358] The spatial and temporal relations of which Eddington speaks further on are these :

Every cell of space in the bounded universe has one Kālāṇu situated in it (spatial relation) and the continuous changes effected by Kālāṇus in their surroundings give rise to temporal relations.[359]

With regard to the infinity of time, Richard Hughes in his article on 'Physics, Astronomy and Mathematics' says: "It follows from this that the time-dimension cannot come round full circle as we imagine space to do. By going far enough into the future we shall never reach the past. And yet it is not necessary to imagine that time either had a beginning or must have an end." The same is the verdict of Einstein's Cylinder theory quoted on page 42. Eddington expresses the same view when he says: "The world is closed in its space dimensions like a sphere but it is open at both ends in the time dimension. There is a bending round by which East ultimately becomes West but no bending by which Before ultimately becomes After.[360] The learned professor then adds "But the difficulty of an infinite past is appalling...We have been studying the running-down of the universe; if our views are right, somewhere between the beginning of time and the present day we must place the winding up of the universe...There is no doubt (about) a date at which either the entities of the universe were created in a state of high organisation or pre-existing entities were endowed with that organisation which have been squandering ever since." This is all true: the running-down of the universe is called by Jains the *avasarpiṇī Kāla* (unwinding of the universe at a slow rate comparable to the pace of a snake) and the gradual rewinding is called the *utsarpiṇī Kāla* at the end of which the things are in a state of high organisation. These processes are going

358. Ibid. p. 102.

359. Newton's conception of time was different from the present day conception. He regarded Time, Space and Matter as independent entities. According to his view time would continue to go on even if the whole universe contracted to a point. The Jain view widely differs from this but agrees completely with that of Einstein who regards time as a separate entity but inseparably mixed with space, so much so that time has been regarded as a dimension like the three dimensions of space.

360. *The Nature of the Physical World*, p. 83.

on from an infinite past into an infinite future, and consequently there should be no difficulty in imagining infinity of time.

However the reality of time is admitted on all hands. Eddington remarks that "Time is more typical of physical reality than matter."[361] Says Mr. Henshaw Ward : "These four elements (Matter, Space, Time and Motion) are all separate in our minds; we cannot imagine that one of them could *depend on* another or be converted into another."[362] Prof. N. R. Sen, D.Sc.(Cal.), Ph.D(Berlin), says in the same article quoted before; "Time, in classical mechanics, is regarded as a continuously flowing entity absolute in nature. This idea of time is involved in all mathematical analysis and is perfectly self-consistent. But what about the physical time which we measure in our laboratories? A little consideration would show that this cannot be absolute but depends on the condition of the observer."[363]

With regard to the smallest unit of physical time it may be mentioned that Jain writers have given it the name Samaya[364] which is defined as follows:

दोण्हमणूणमदिक्कमकालपमाणं हवे सो हु ॥[365]

(*The time taken by one paramāṇu* (*the electron or the positron*) *in traversing the distance between two of them placed side by side in space is called the Samaya* i.e. the time taken by a Paramāṇu in going from one space-point to another with a slow speed.)

The biggest unit of time is the Mahākalpa made up of two æons, *āvasarpiṇī* and *utsarpiṇī*, each consisting of 4134526303082031777495121920000000000000000000000000000 0000000000000000000000 (77 digits) solar years. (The Brahma Kalpa of Hindus also cosists of 77 digits but the digits do not agree.)

Then there are intermediate units of every day use.

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361. Ibid. p. 275.

362. Quoted from *Exploring the Universe*.

363. See *the Proceedings of Physics Seminar*, University of Allahabad, July 1925, Article on *Relativity*.

364. Unit of pudgala is Paramāṇu, unit of space is Pradeśa or the space-point and so the ultimate unit of time is the Samaya.

365. *Gommaṭa Sāra*, (Jivakaṇḍa) 573.

...Thus time as an independent reality is established on modern evidence.

SŪTRA 40.

सोऽनन्तसमयः ॥४०॥

SO ANANTA-SAMAYAḤ (40)

(An infinitesimal fraction of time is called the samaya.)

This Sūtra defines the unit of time. Just as *paramāṇu* is the unit of mass and space-point or the *pradeśa*, the unit of three-dimensional space, similarly a *samaya* is the unit of time and is defined as the time taken by a *paramāṇu* to traverse one space-point or the time taken in going from one *kālāṇu* to another. Since there is only one Kālāṇu in each space-point, the two definitions are identical.

In the words of the 1946 Nobel Prize Winner Physicist, P. W. Bridgeman : "We cannot think of an interval of time as the sum of moments without duration."

Physicists began to deal with ultra short time intervals after the discovery of radioactivity. Some types of atoms had a very short life. Polonium-212 for instance, has a half life of less than a millionth (10^{-6}) of a second. It decayed in the time it took the earth to travel one inch in its 18½ mile per second journey about the sun. Some sub-atomic particles break down in far shorter intervals of time. In a bubble chamber, certain particles, travelling at nearly the speed of light, manage to form tracks three centimeters long after forming and before breaking down. This corresponds to a life time of a ten billionth (10^{-10}) of a second.

In the 1960s, particularly short-lived particles were discovered whose half life period was (10^{-23}) seconds i.e., ten trillionths of a trillionth of a second (एक सैकेंड का शंखवां भाग और उसका भी दस लाखवां भाग).

This is the limit of shortest interval of time reached by science so far. The Jain unit of time (Samaya) is smaller still.

SŪTRAS 41 & 42.

द्रव्याश्रया निर्गुणा गुणाः ॥४१॥

DRAVYĀŚRAYĀ NIRGUṆĀ GUṆĀḤ (41)

तद्भावः परिणामः ॥४२॥

TADBHĀVAḤ PARIṆĀMAḤ (42)

(1) Attributes can never exist independently of the substances of which they are the attributes and one attribute cannot be the substratum of another attribute.

(2) The change in the character of attributes of a substance is called Pariṇāma (modification).

The same view is expressed in Pañcāstikāya Sāra.

दव्वेण विणा ण गुणा गुणेहिं दव्वं विणा ण संभवदि ।
अव्वदिरित्तो भावो दव्वगुणाणं हवदि तम्हा ॥[366]

(There can be no quality without substance or substance without quality; the two are inseparable in their nature.)

According to Jains, Dravya is a dynamic reality having a continuous flow parallel to the flow of time. It cannot be thought of apart from its qualities which in their turn are not separate from the Dravya. In other words, qualities can only reside in substances and substances are bundles of qualities. One cannot think of fluidity apart from a fluid. The difference between a substance and its attributes is not a difference of existence but only that of reference.

The triple nature of reality, i.e., continuance through origination and destruction gives to a substance a characteristic mode of existence every moment.

The modifications which the six Dravyas undergo have been divided into two classes. *arthaparyāya* and *vyañjana paryāya.* All the six Dravyas have the former but the latter is associated with spirit and matter only. The former refers to the intrinsic changes in Dravyas while the latter has a somewhat fixed duration of existence. For instance, a pot is a *vyañjana paryāya* of matter; similarly men and animals are *vyañjana paryāyas* of the soul substance. Read also pages 77-80 in this connection.

366. Pañcāstikāya *Sāra,* 13.

In the Śwetāmbara text the following three Sūtras occur in addition :

अनादिरादिमांश्च ।

रूपिष्वादिमान् ।

and

योगोपयोगौ जीवेषु ।

(The modification may be of eternal or transient nature. Eternal changes occur in non-corporeal Dravyas, Soul, Space, and Media of motion and rest. Modifications in matter are of transient nature.

Digambaras have also contributed to these ideas in the commentary *Tattvārtha Rājavārtika* with some modifications but we omit a detailed description because of their little importance.

This brings us to the end of our journey.

THE SUMMARY

ACCORDING to Jain Cosmology the universe comprises six Dravyas, Substances or Realities. A Dravya, substance or reality has been defined as any substantiality or existence which has the important characteristic of persistence through change, i.e., it undergoes a transformation and re-appears in a new form while the original substantiality still abides. Also a Reality is the basis in which attributes rest and modifications take place.

The six realities are (1) The Soul, (2) Matter, (ajīva) (3) Space, (ākāśa) (4) Time, (kāla) (5) a Non-material medium for the motion of souls and the propagation of matter and energy (dharma) and (6) the Field through which the gravitational and electromagnetic forces operate for maintaining the untiy of the microscopics as well as of the macroscopic worlds (adharma).

The number of substances is fixed as six ; it can never be seven or five. These substances are eternal and unchanging in their characteristics. Leaving aside the substance matter all others are non-material and formless and hence devoid of all properties associated with matter.

For explaining cosmical and physical phenomena the three *fundamental units* of space, matter and time have been chosen corresponding to the units of length, mass and time i.e., the C.G.S. or the F.P.S. systems of modern science. The unit of space is called the Pradeśa (space-point) and is defined as the space occupied by one indivisible particle of matter and capable of being occupied by even an infinite number of such particles under abnormal condensations. The unit of matter is the *paramāṇu* (the smallest indivisible particle of matter,—the electron, negative or positive) and the unit of Time is the *samaya* (समय), which is defined as the time required for a *paramāṇu* to traverse one space-point.

THE SOUL

The soul is the reality which possesses the faculty of knowing and perceiving, in which the sensations of pain and pleasure inhere and through which the volition functions. Modern experimental psychology has already discovered the electrical counterpart of the soul, called the *Taijas-Śarīra*. (Read pages 56-57). The soul has the potency of changing its size by contraction and expansion. It can occupy the smallest possible body of a bacteriophage or the biggest body of a whale fish. Although the soul substance is non-quantumistic in nature, one single soul can fill every iota of space in the whole universe under special circumstances. Since a body grows from a microscopical size in the mother's womb to its full proportions and contracts again, at the end of its earthly career, to re-incarnate into a new seed, it follows that the size of the soul cannot remain fixed. Modern science identifies life with protoplasm or the living cell and it is well-known that protoplasm possesses a remarkable property of contraction under external stimuli. Soul experiences pain, pleasure, life and death through the agency of karmic matter. This theory of transmigration of soul is an extraordinary conception also supported by Hindu and Buddhist philosophers. According to the Jain view all actions of embodied living beings, whether mental or physical, are followed by an influx of fine molecules of energy towards the soul, the latter constituting what is called Kārmaṇa body. To use the modern language, the activities of mind and matter constitute a super-radio, with the quintillions of living cells sending out their individual waves to be tuned in by quadrillions of receiving sets in the brain. Influx of these waves is the influx of subtle Karmic matter. Karmic matter, we can call *the fourth state* of matter, the other three being *Solids*, *Liquids* and *Gases*. Activity of a good kind attracts meritorious while activity of a bad kind attracts the opposite kind of Karmic matter. The Karmic body is responsible for dragging the soul from one physical body to another, and it keeps the soul bound to the confines of the universe owing to the gravitational forces operating on all sides. When Karmic matter is shed off the soul by following the Path of Liberation, the latter, being the lightest substance, rises up to the top of the universe and rests

there as Pure Effulgence Divine. It cannot travel further on owing to the absence of luminiferous æther beyond, æther being the necessary medium for motion.

In recent years the scientists are trying to explain the processes of life viz., growth and reproduction in terms of special properties of various kinds of proteins and the two nucleic acids DNA and RNA. Although the artificial synthesis of a *biologically active* living cell, which automatically grows by multiplication has been reported, it has not been possible so far to correlate the proteins, DNA and RNA with functions of memory, thought, reason, logic, intuition, decision and free-will. In other words, consciousness could not be explained on the basis of physics and chemistry and hence the existence of soul remains unchallanged.

The existence of soul and its transmigration has been amply corroborated by the recent researches in para-psychology.

THE MEDIA OF MOTION AND REST

The Jain philosophers recognized in the world life, matter and space but these were not enough. There could be no stable world if there were nothing to prevent the souls and atoms from flying about and being scattered throughout the infinite space. This led to the hypothesis of a *medium of rest*, the *Field* through which the binding forces operate. But if there were the Field alone there could be no motion at all in things and bodies. There would be an eternal paralysis of Reality. To remove this difficulty another *medium of motion* had to be postulated. But the trouble is not yet over. If the two media exist within a spatial limit one guaranteeing motion and the other rest, then the things in motion must be in motion for ever and things at rest must be there for ever. But our experience is not of that kind, and therefore it is assumed that the two media are inactive and neutral in themselves, yet indispensable to the composition of the world. They are non-material, non-atomic, and continuous media pervading every iota of the whole universe, although for purposes of practical convenience they are regarded as made up of space-points. But they possess the characteristic properties of a Reality. viz., they undergo a cycle of changes, old forms gradually disappearing, new forms appearing and at the end of the cycle the

original pattern is again there. In fact a stationary wave-motion, explained in pages 79-80 of the text, is constantly taking place in these invisible media, as if the heart of the whole universe were throbbing in tune with the Almighty. As every student of physics knows there are nodes and antinodes (places of no disturbance and maximum disturbance) in a system of stationary waves. Who can say that the positions of nodes (slight swellings at which the leaves arise) and internodes (smooth parts between the nodes) in the stems of plants are not determined by the positions of the nodes and the antinodes in the media of motion and rest ?

The modern analogue of the medium of motion is the æther. It is undoubtedly regarded as the medium through which electromagnetic waves travel. In the beginning the scientists associated material properties with æther which gave rise to serious difficulties and contradictions. However the idea of æther, after suffering many cataclysms, survives to this day. It is now regarded as an imponderable fluid surrounding every particle of matter and penetrating every atom and the molecule. Physicists made various assumptions about æther in order to explain the electromagnetic phenomena, viz., that (1) moving bodies carry æther along in their motion ; (2) moving bodies do not carry æther with them but they only move in a calm æther-sea, or (3) æther is partially carried and partially not carried by the moving bodies. But all these assumptions miserably failed to explain facts and were contradicted by the most delicate experiments. Neither motion of æther nor motion *through* æther could be detected. The reason probably is that æther does not possess any of the properties associated with matter. We would like to point out that Jain physics postulates the existence of stationary waves in æther and this assumption needs to be worked out mathematically. It is a new idea and may lead to fruitful results. Even to this day the æther problem remains a great puzzle and we read on 184 of *The Evolution of Physics* : "All our attempts to make æther real failed..... After such bad experiences, this is the moment to forget the æther completely and to try never to mention its name. We shall say : our space has the physical property of transmitting waves and so omit the use of a word we have decided to avoid. The omission of a word from our

vocabulary is, of course, no remedy. Our troubles are indeed much too profound to be solved in this way !" A similar trouble was anticipated by the Jain thinkers when they asked the question : What is the harm if we associate the functions of motion and rest with the space which exists everywhere ? (See page 105 ante.) And the answer given was : By so doing the division between the finite universe and the infinite space beyond would disappear. It is interesting to note that if we regard our universe as infinite, it cannot be stable at the same time, for in that case all our energy would get scattered into the infinity of space and the attractions of myriads of other universes filling the infinite universe on our universe would scatter it into infinity. In order, therefore, to maintain the stability of our universe running from an infinite past into an infinite future the universe must be conceived as of finite dimensions so that when the energy travelling with the velocity of light, 1,86,000 miles/sec., reaches the confines of the universe it gets reflected and is not lost. The total energy of the universe will in this case remain constant. Einstein introduced this idea of finite universe by making the odd postulate that space gets warped under the stress of matter. The idea of the space becoming curved due to the presence of matter and thus closing in to form a finite universe is a hard pill to swallow. Jains also regard the universe as finite[367] but the case of this finiteness is more easy to comprehend. According to Jain view there are no media of motion and rest beyond a certain limit called the Loka and consequently matter or energy can never get out of this limit with the result that the total energy of the universe remains constant throughout eternity. The pure mathematical space extending to infinity beyond without the presence of any grain of matter or time is called the *aloka*.

As we have already remarked the modern scientific equivalent of the 'medium of rest' is the Field through which the forces which maintain the cosmic unity operate. Without this medium there would be no coherent system of souls and atoms, there would be only chaos—no world would be possible. The Field

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367. The volume of the universe, according to Jains, is 343 cu. Rajjus, a Rajju being a quantity of the order 10^{21} miles. (See pages 91-92) The use of the word *Brahmāṇḍa* (universe of the ellipsoidal from) by Hindus for the universe is also suggestive of the finitude of the latter.

is similar to æther in so much as it is also a non-material, invisible, non-atomic, continuous and passive medium but its function is just opposite. These two media interpenetrate in every bit of the universe and do not interfere with the functions of each other. It is a case similar to that of the co-existence of electrostatic, magnetostatic and gravitational fields, which, although of different character, do not mix; each preserves its individuality regardless of the other. For instance, if both electric and magnetic poles are at rest, there is no action between them, neither attraction nor repulsion. In the language of science this would be expressed by saying: an electrostatic field does not influence a magnetostatic field and *vice versa*. The discussion of pages 108-109 ante will show that the scientists are still in doubt with regard to the true nature of the Field. They are making the mistake of associating material properties with this non-material properties with this non-material medium and hence the whole jumble.

In conclusion, it is worthy of notice that although all Indian philosophies have devoted very great pains to the theories of world evolution, none of them but the Jains could think of these vital principles of motion and rest without which a stable world structure is impossible and incomplete.

ĀKĀŚA OR THE SPACE

According to Jain philosophers the term Ākāśa means the mathematician's pure space and not the primeval substance of the Hindus out of which the Creation was evolved. The chief function of space is to accommodate the infinite physical objects, living-beings, the media of motion and rest, and the time. The space is divided into two main divisions: the Lokākāśa, which is co-extensive with these objects and the Alokākāśa or Anantākāśa, which is pure space extending to infinity beyond Lokākāśa. In the Infinite Beyond there are no objects animate or inanimate. Not a tiny molecule of matter nor a stray soul would step beyond the limits of the Loka. The system of objects is held together by the static and the dynamic principles, the æther and the Field and these principles are confined to Lokākāśa. We have already explained in the last section why the functions of motion and rest cannot be associated with space. According to the views of modern science the total

amount of matter which exists is limited and the total extent of the universe is finite. The totality of space is so curved that a ray of light, after travelling in a direct line for a long enough time, would come back to its starting point. A ray of light would, according to a rough estimate, take about ten trillion years for the round trip in the totality of curvature. Einstein connects the curvature of space with the amount and distribution of matter in the universe. Space, if there be matter inside it, bends round until it closes up. The more matter there is, the smaller space there must be and space could only be of literally infinite extent if it contained no matter at all. Just as the surface of a sphere is a curved surface and a closed surface enclosing a three-dimensional volume, so is our three-dimensional space a curved space and a closed space enclosing a four-dimensional continuum. One startling conclusion from Einstein's theory is that both space and time vanish away into nothing if there be no matter. We cannot conceive space and time without matter. It is matter in which originate space and time and our universe of perception. It should be noted that while Jain philosophy regards only part of the universe as finite and an infinite pure space beyond, Einstein regards the whole universe as finite with nothing beyond it, although it is quite inconceivable that there should be no space beyond a certain space. When Professor Eddington declares that the physicists cannot in any case conceive of space is void, it is clear that they do not believe in *space as a substance in itself*. Our view is that space is a real eternal substance, for pure expansion is not thinkable in the absence of a substance in which it might inhere. Space without matter and time is not void.

THE TIME OR THE KĀLA

Jain philosophy regards time as one of the six fundamental realities of the physical universe. Time is divided into apparent and absolute time. Apparent time is that which assists substances in their continuing to exist, is the auxiliary cause of different kinds of modifications in them and is measured by some conventional units of longer or shorter durations. The absolute or real time, existing behind apparent time, consists of innumerable grains, called the Kālāṇus, residing one in each space-point of the finite universe, the Lokakāśa, like heaps of

jewels. These grains never mix or coalesce with one another; they are invisible, formless and inactive. The time substance differs from the other five substances in one important respect and it is this : Time is unindirectional. This *one-way property* of time has been given the name, time's arrow, by Eddington. Time has only a longitudinal extension, no spatiality and hence no indivisible and inseparable parts called the Pradeśas or space-points. The instants of time, i.e.. Kālāṇus are so arranged in space that their arrangement can be represented by a mono-dimentional mathematical series, i.e., a series of linear order. This characteristic distinguishes time from the other five entities which require a multi-dimensional series to represent their surface extension. In Einstein's theory the space and time are mixed up in a strange way. According to this theory we cannot conceive of space and time without matter. According to the Jains also the grains of time are mixed up with space, Kālāṇu (the quantum of time) in each space-point, lying static and permeating every iota of the Lokākāśa (the finite universe). In the infinite pure space extending beyond Lokākāśa, no other substance exists but space ; there is no matter and hence no time also. Newton regarded time, space and matter as independent entities. According to him time would continue to go on even if the whole universe contracted to a point. The Jain view widely differs from this but agrees completely with that of Einstein. With regard to the infinity of time the Jain view supports Professor Eddington's following statement : "There is a bending round by which East ultimately becomes West but no bending by which Before ultimately becomes After". In other words, time has neither a beginning nor will it ever come to an end.

THE PUDGALA OR MATTER AND ENERGY

The sixth and the last entity composing the physical universe is what is called by Jains, 'the Pudgala'. It is worthy of note that the use of this word is quite peculiar to the Jain philosophy; it does not even exist in the dictionaries edited by non-Jain writers. The physical manifestations of Pudgala are the matter and energy. The root-meaning of the word Pudgala is : 'the entity which manifests itself in various forms by the process of combination and disintegration'. One who is familiar with the

modern developments in atomic physics cannot but admire the choice of the word Pudgala to denote matter and energy. We now know full well that all atoms are an assemblage of electrons, protons and neutrons. In the phenomenon of radio-activity atoms are seen disintegrating themselves of their own accord into others and in the phenomenon of artificial radio-activity bombardment by alpha particles, protons or neutrons brings about such transformations as the conversion of aluminium or sulphur atoms into those of phosphorus. Figs. 5 and 6 of pages 45-46 show beautifully how a foreign alpha particle bullet fills an empty place in the nucleus of a nitrogen atom and produces an atom of oxygen. Similarly Fig. 7 of page 47 shows how a foreign proton bullet gets embedded into the nucleus of a lithium atom and completes the alpha particle. At the same time the nucleus bursts and the two alpha particles fly in opposite directions. It is therefore a case of the processes of combination and disintegration following in rapid succession. Fig. 8 of page 48 is interesting. An alpha particle is short into the nucleus of an atom of beryllium metal with the result that the shot is absorbed, beryllium is converted into carbon and the neutron is rejected out of the original nucleus. Here also the processes of combination and partial disintegration are playing their role. Many more such examples can be multiplied. As we shall see later the molecules are formed by the atoms by similar processes of division and union. Thus the use of the word Pudgala for matter and energy fully justifies itself.

The Chief characteristic of the substance Pudgala is that it is the subject of sense perception ; it has a form, in contrast with the other five constituents of the universe which are without form. The physical properties of hardness, density, temperature and either positive or negative charge are associated with it. It has one of the five tastes : sweet, bitter, sour, saltish or astringent ; a good or bad smell and one of the five colours, black, red, white, yellow or blue depending upon the temperature. Not only in the gross form of matter are these physical properties associated but the Jain Ācāryas have extended them to the ultimate particles of matter also. As mentioned on page 144, every *paramāṇu* (electron or positron) has one of the five tastes, one of the five colours, a good or a bad smell and a positive or a negative electric charge. Matter is divided into six

sub-classes : Solids, Liquids, Gases, Energy, fine karmic matter and extrafine matter consisting of the streams of the ultimate particles of matter. Until some sixty years back the classical physics of Newton and Galileo regarded energy as perfectly weightless and without any association with matter. It was the genius of Einstein who definitely proved that every form of energy has mass and that there is no difference between matter and energy but that of the form. It is really woderful to note that this truth was already discovered several centuries ago by the Jain philosophers. They regarded every form of energy as a manifestation of Pudgala, and hence one form of energy could be intra-converted into the other. It is really interesting to see that, whereas in the history of modern science the nature of heat, light and electricity could not be elucidated for a long time, heat and electricity being regarded as fluids for several centuries, they were already known as modifications of energy to the Jain thinkers several millenniums ago.[368]

Matter is then thought of as made up of Skandhas (molecules), Skandhadeśas (atoms), Skandhapradeśas (ionised or stripped atoms) and Paramāṇus (invisible elementary particles such as the electrons and the positrons). In conformity with the version of the modern kinetic and electron theories of matter, the Jain philosophy also regards elementary particles inside an atom and the molecules in a piece of matter to be in a state of motion. (Vide page 140 ante). With regard to the formation of molecules three processes are enumerated by the Jains, viz., division, union and the combined process of simultaneous division and union, corresponding to the electro-valent, co-valent and co-ordinate methods of linking atoms in modern science. The breaking up of molecules[369] is attributed to two

368. The true nature of sound was also known to the Jain thinkers. Unlike the other Indian systems of thought which associate sound with aether or space (Ākāśa), Jain system explains it as being due to the vibrations of the molecules. Sound is further divided into Musical sounds and Noises and the musical sounds produced by the vibrations of strings, reeds, pipes, bells and stretched membranes are given different names (See pages 131-133).

369. According to the Jain view, the modern atom is in fact a molecule and the author of the present work makes bold to say that some thing akin to Raman effect *will some day be discovered* in the atoms also, thus bringing them into the category of the molecules. Already the nuclear spin and

different causes, *internal* and *external*. The phenomenon of radio-activity is an example of breaking up due to some internal cause and dissociation of the molecules in solution, the thermal and pressure ionisations and breaking under artificial bombardment are examples of breaking due to external causes. The phenomenon of ionisation is described as due to the simultaneous separation and union of the molecules. "Just when one molecule breaks, the detached part attaches itself to another molecule", says the author of Sarvārtha Siddhi. The formation of the mechanical mixtures of matter and that of the chemical compounds as a result of reactions were known respectively as *No-karmabandha* and *Ajīva Viṣayabandha*. Coming to the subject of extrafine matter, the sixth and the last division, as quoted on page 73 ante, it is defined as composed of Skandhas made up of one or two paramāṇus and no more, and paramāṇu is the last particle of Pudgala which cannot be sub-divided by any means whatsoever. The paramāṇus are of two kinds called the Kārya Paramāṇu and the Kāraṇa Paramāṇu which have their modern analogues in the electron and the positron. These names are very significant in the sense that there can be no karya (action) without kārṇa (cause) and as such they should occur in pairs. This is supported by the fact that when light elements are bombarded by gamma-rays electron-pairs are observed to appear in the Wilson Chamber, a positron and an electron shooting out simultaneously from the same place. The other elementary particles like the neutrons, protons, negative protons and the mesons have all been formed by the union of these two types of Paramāṇus according to certain laws.

The union of the electrons and the positrons to form different kinds of matter is attributed to the differences in the degrees of Snigdha and Rūkṣa properties of these particles. As mentioned on page 160 f.n. the discharge of electricity between the clouds has been attributed, by the author of Sarvārtha Siddhi, to the same property of Snigdhatva and Rūkṣatva. Referring to the phenomenon of atomic-interlinking Dr. B. N. Seal in his book *The Positive Sciences of the Ancient Hindus* (London), suspects that "the crude but immensely suggestive

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nuclear statistics of nucleii of atoms like hydrogen, nitrogen etc. have been calculated with the help of Raman lines.

theory of chemical combinations (of the Jains) is possibly based on the observed electrification of smooth and rough surfaces as the result of rubbing". (Mark that the words 'Snigdha' and 'Rūkṣa' have been translated as smooth and rough.) In Sūtras 33-36 the laws of these combinations are discussed in detail and in Sūtra 37 the formation of neutral atoms from positive and negative charges, the formation of positive and negative ions and as to how the same atom behaves sometimes as electro-positive and sometimes as electro-negative are explained. According to Professor Andrade, one of the greatest problems of new chemistry is to find out the laws which will enable us to predict which combinations of protons and neutrons are stable, which unstable and which impossible. According to the Jains, the laws are the following :—

(1) A positron combines with a positron or an electron with another electron if they differ in their degrees of Snigdhatva or Rūkṣatva (energy levels ?) by two units.
(2) A positively charged particle (a positron or a proton) can unite with a negative elementary particle and vice versa.
(3) According to the Digambara view there is no possibility of union for all combinations of elementary particles *having the same energy level*, while the Swetambaras recognize such a possibility if the union is between the particles of opposite kinds.
(4) Particles at the lowest energy level do not unite,—a sort of degenerate state.
(5) The union of the various particles of different energy levels may form an odd or an even series.
(6) The power of uniting or separation is absent in combinations composed of only two elementary particles such as the neutron.

The law No. (4) recognizes the possibility of the free occurrence of the electrons and the positrons such as the conductivity electrons in the metals and the positrons occurring in the cosmic ray streams.

The elementary particles like the neutrons, the protons, the negative protons and the various mesons can be looked upon as formed out of the two elementary grains, the electrons and the positrons. Although it is difficult to conceive how electrons

could possibility be packed together to form of the mesons of different masses enumerated on page 161 f.n. or how a proton could be formed out of the positrons since, as the charges are of the same sign, the tendency would be for infinite dispersion instead of abnormal condensation, but it appears that at extremely small distances the law of repulsion changes into a law of attraction as in the case of the gravitational phenomenon cited on page 95 Further, it is on the basis of this abnormal condensation of similar charges that the formation of nuclear matter has been explained (vide page 13 ante).

The negative protons, the mesons or the heavy electrons furnish examples of Rūkṣa particles combining with Rūkṣa and a molecule of oxygen is an example of a Rūkṣa atom combining with Rūkṣa; protons have been formed by the union of Snigdha particles. In the nuclei of atoms we have the Snigdha and Rūkṣa particles together and in the neutron, we have a close union of these two. With regard to the particle like the neutron—one which is formed by the union of only two particles—it is mentioned that it has no power of uniting or separation (vide page 139). In other words, a neutron cannot be broken up into a proton and an electron or two neutrons cannot unite together to form a third particle. In the various molecules of substances we have a union of Snigdha and Rūkṣa atoms, such as in the molecule of common salt the atoms of sodium are Snigdha and those of chlorine Rukṣa. They break up as such when common salt is dissolved in water because the strength of the bond between the atoms is not great. The necessary condition for union, discovered by the Jain thinkers, is that the uniting particles must differ in their degrees of Snigdhatva and Rūkṣatva by two units. These differences in degrees it is difficult to identify but it is something like the Pauli's Exclusion Principle. Fermi-Dirac Statistics gives us a means of distinguishing between the electrons of different energy levels. Not only in the electrons but also in the atoms there is fundamental difference of energy such that we could give them different names, George, Edward, John, etc. Otherwise how can we account for the fact that in the phenomenon of radio-activity one atom lives only a few seconds and its apparently identical neighbour many years. It is due to these inner differences in atoms that molecules with different binding strengths are produ-

ced, the strengths now being measured quantitatively by the technique of Raman Effect. The formation of the isotopes, mentioned on pages 167-168 also points to the fact that it is probably a difference of two units in the Snigdhatva or Rūkṣatva which brings about a unit difference of weight in the atoms of different elements, but because the operations of union appear to be carried out either in the deep interiors of the nuclei of the atoms or in certain secret corners of the interstellar space, the laws of union have so far not been discovered fully.

We cannot close this summary without making reference to Sūtra 32 which deals with the subject of 'relativity' under the name of Syādvāda theory. The aim of this theory is to co-ordinate, unify, harmonize and synthesise the individual view-points into a practicable whole or in the words of Professor Dhruva "in this theory the discordant notes are blended so as to make a perfect harmony." It is not a theory of mere speculative interest but it has a bearing upon man's psychological and spiritual life. It has been compared to the Einstein's theory of relativity but it is much simpler and less elaborate as compared with relativity. Relativity is mainly the theory of the physicist but the Syādvāda theory has only a philosophical bearing. Still the contributions of Syādvāda and Relativity to the ultimate outlook on life and its problems are almost the same. According to Syādvāda the existence is a huge complexity; neither can human mind properly understand it nor can the human language adequately express it. As such the absolute statements are out of court and all statements are true from a certain point of view only. According to Relativity all our terms of expression like east and west, right and left, up and down are relative; they are not the same for all the observers and under all conditions; they are not absolute but merely relative to something. Relativity is therefore the theory of the statement of general physical laws in forms common to all observers. Just as the theory of Syādvāda attempts to reconcile the various conflicting schools of philosophy, not by inducing them to abandon their favourite stand-points but by proving to them that the stand-points of all others are alike tenable and represent different aspects of truth, so has the theory of Relativity shed light on age-old controversies. Whether the earth moves round a stationary sun or the sun moves round

a stationary earth was debated problem for long. According to Relativity both the statements may be right or wrong depending upon the viewpoints. The truth is that the motion between the sun and the earth is relative. We may assume either the sun or the earth to be stationary depending upon the mathematical convenience.

It is worthy of note that this brilliant theory of stand-points originated with the Jain thinkers: there is hardly a counter-part of it in other systems of philosophy, oriental or occidental.

APPENDIX 'A'

DOOM OF THE UNIVERSE

According to Hindus all matter, space and time are engulfed into the Supreme Being at the time of Mahā Pralaya and then it is He who unfolds the universe again, whereas according to Jains the nature of the universe itself is such that after it has completely run down, it re-generates itself by carrying out the cycle in the reverse order.

According to modern science, the universe is gradually running down in the material sense of the word. In the language of science, we say that the entropy of the universe is tending towards the maximum. This has been proved mathematically by Max-well from the second law of thermodynamics. In nature, heat is constantly flowing without interruption from a body at a higher temperature to a body at a lower temperature and air automatically flows from a region of high pressure to a region of low pressure. Thus there is a tendency towards equalisation of temperature and pressure all over the universe.

The Efficiency of a heat engine is greater if the difference of temperatures between the source of heat and the exhaust is large i.e. greater the difference of temperatures, the higher is the efficiency. In other words we can say that the availability of energy for doing work is becoming less and less every moment and when the entropy of the universe reaches its maximum, no work will be possible. The state of affairs will correspond to the idea expressed in 'Mariner's Poem' 'water water everywhere, but not a drop to drink.'

The sum total of energy in the universe will be the same as before but it will not be available for work. No motion of any kind will be possible. The whole universe together with its

inmates will be at a stand-still. Living beings will neither be able to move nor to breathe. Life of all forms will be extinct. What next? is a glaring question before the scientists. They believe that the universe cannot end thus. Some unknown force must rewind the clock of the universe so that it may be set running once again. According to Hindu belief the rewinding is done by the Almighty God whereas according to Jains the process is automatic.

There is another line of thinking in science. According to this, sun is the source of energy for all life on earth. It is on the advent of the Spring that buds open, it is the heat energy which brings forth new life from within an egg; it is the energy of the sun which the human beings, animals and vegetables utilize for their growth. The sun is a hot body with its surface temperature of 6000°C and in the interior the temperature is two crores of degrees Centigrade. It is radiating energy incessantly in all directions and as such it ought to cool down some day to the temperature of its surroundings. But it has been maintaining its temperature for billions of years and will continue to do so for a few billions of years more, when it will altogether disappear. The reason is this: several milleniums before Christian era, our Tirthankars taught that heat and light are fine forms of matter and have, therefore, weight.

This discovery was made by Einstein in modern times. Sun is losing heat by radiation and its temperature is constant. It means, it is losing mass. It has been estimated that its mass is being reduced by 250 million tons per minute and therefore it will disappear after a few billion years. The total mass of the sun is 2×10^{27} tons. When universe becomes devoid of solar energy, all life will disappear and it will be a sort of Pralaya (प्रलय).

In recent years another interesting discovery has been made. It is well known that the magnetic North Pole does not coincide with the geographical North Pole. There is an angle between them. Now it has been found that the magnetic poles of the earth are slowly rotating and a time will come when the North pole will go into the position of South pole and vice-versa. In between there will be a period of 100 to 200 years when the earth will have no magnetism at all, because when we go from a negative quantity to a positive quantity, zero comes in between.

The Earth's magnetic field acts like an umbrella for the destructive showers of cosmic rays coming profusely from interstellar space. The Earth's field deflects them to one side and it is only in very small numbers that they are able to reach us. The rotation of the poles has a period of about 7,50,000 years and the last reversal took place some 7,00,000 years back. After forty or fifty thousand years, it is likely to occur again. This is a very brilliant confirmation of Jain Siddhānta according to which Mahāpralaya is going to take place exacty after 39500 years. At the time of zero magnetic field, all cosmic rays will exert their maximum destructive force and there will be an utter destruction i.e. Mahāpralaya.

At the time of reversal of the poles, there are very great genetic mutations with the result that the creatures born are either too small in size or too large i.e. entirely new forms of life are produced.

On June 30, 1908 there was an unusual explosion in Siberia in the Soviet Union. The explosion may be compared to a 30 megaton hydrogen bomb explosion i.e. equal to 1500 Hiroshima atom bombs exploding together. American scientists are of the opinion that it was an explosion caused by an anti-matter intruder of about 1 Kg. weight that entered accidentally into our earth. If some day a lump of antimatter weighing about 10 tons, enters into our universe, it will create such a gigantic explosion that the whole world will be reduced to dust.

There is another view with regard to the doom of our Earth. The Earth is gradually increasing in mass at the rate of 20,000 tons per year on an average due to entry of meteorites and cosmic dust. Since the Earth is rotating like gyroscope, constant increase in its mass means slowing down of the angular velocity. From this we can easily conclude that some day its rotation about its axis will cease. The result will be that on one side there will be eternal day and on the other side an eternal night. The day side will have a burning temperature where water will be converted into vapours. On the other side, there would be extreme cold. Under either conditions living organisms cannot survive.

As the sun is also loosing its mass incessantly, it will not be able to exert its maximum pull on the Earth. Under these

circumstances it is very likely that the Earth may collide with some other celestial body and be broken into pieces.

The concept of Mahāpralaya in Jain Siddhānta is a different story. In what is called as Bharata Kṣetra by the ancients, the cycle of Time is first divided into two parts, called the Utsarpriṇı (उत्सर्पिणी) and Avasarpiṇi (अवसर्पिणी). Then each of them is further divided into six epochs. During the *utsarpiṇī kāla*, there is a gradual progress and during the Avasarpiṇi Kāla there is a gradual decline. Utsarpiṇī comes again and so on alternately. Hunger is excited after an interval of 3 days and is immediately satisfied by taking a pellet of food of the size of jejube (बेर) obtained from *Kalka Vṛkṣas* (celestial trees). The beings of this age have not to answer the calls of Nature and are free from every kind of disease. Twins are born, a male and a female and behave as husband and wife after they grow up. The clothes and other necessities of life are all provided by the celestial trees. The parents die together after the birth of the twins and the latter grow up within 50 days by sucking their thumbs.

The second epoch is of smaller duration than the first. The height of the human body and the span of life are reduced. The beings of this period also get all their requirements from celestial trees.

In both these epochs there is no ruler or the ruled, the status of all people is equal. The luminosity of the celestial trees is so great that the light from the sun and the moon is obscured. Even the cruel animals like lions have peaceful temperament.

During the third epoch the height of beings and their span of life are still further reduced. The beings of this Age take their food an alternate days and the quantity of food is increased from a jejube size to that of myrobalan. It is in this epoch that the fourteen Kulakaras law givers (called Manus in Hindu Śāstras) are born. Before the birth of Kulakaras there are no names of individuals. The wives address their husbands as Ārya and husbands calls their wives as Ārye. There is no caste distinction. They all belong to one caste—Humanity. All comforts flow freely and are equally available to all persons. Man has not to exert himself for his livelyhood. This Age is known as Utopia (Bhoga Bhūmi).

During the fourth epoch the height and the span of life is reduced still further. At the end of the epoch the height dwindles down to about 10 feet. Karma Bhūmi begins as man has to work now for earning his livelihood. With the beginning of this epoch, States are formed, rulers come into existence, people begin to perform religious functions and begin to marry. New and improved methods of trade, agriculture and industry are devised. There is material progress no doubt but spiritually the man deteriorates. It is during this epoch that the 24 Tirthankars are born at intervals of time, who enlighten the world with their divine knowledge. Attainment of *Mokṣha* (Salvation) is possible only up to the end of this epoch. At the fag end of this epoch some new seas are born, i.e. great land masses are *sub-merged* under water.

The fifth epoch in this declining cycle is of 21,000 years. In this epoch the height, the age and the physical strength of man are very much reduced. The maximum span of life is 120 years and is gradually reduced at the rate of 5 years after every one thousand years. By the time the epoch ends, the maximum age is 20 years and the height 3 feet. At this time men become carnivorous and live upon trees like monkeys. They do not observe any kind of religion. All virtues are lost in them. We are at present living in the fifth epoch.

During the sixth again epoch of 21,000 years, things worsen still further. During the last 49 days of this epoch, there is rain of dust for first seven days, violent storms for next seven days, heavy rains during the third week and rain of fire during the fourth week. During the next three weeks, there is rain of stores, earth colds and wood respectively, The result is that all living beings, animals and birds are destroyed. In fact the whole cities are razed to the ground. The Jain Tīrthankaras have called this period as Pralaya. Only the sexual beings are removed to places of safety by the Devas. Here the cycle of Decline ends.

After this, the cycle is repeated in the reverse order and after undergoing six similar stages of time status quo is restored.

In conclusion we repeat below the main points of difference between the three systems of thought.

1. According to Hindus the whole earth is submerged under water 15 times during one kalpa, whereas according to

Jains it is only once at the end of fourth epoch and that too partially.

2. According to Hindus in Mahā Pralaya all matter, space and Time are engulfed into the Supreme Being and then it is He who unfolds the universe again whereas according to Jains the nature of the universe itself is such that after it has completely run down it regenerates itself by carrying out the cycle in the reverse order.

3. Scientists believe in the eternity[370] of the universe but they invoke the aid of some unknown force to rewind the universe when it has completely run down.

370. According to Scientists our Universe is expanding. But they say that the rate of expansion is now slowing down and some day it will completely stop. Then the Universe will begin to contract and when the concentration of matter becomes enormously high it will explode and begin to expand again. This alternate cycle of expansion and contraction will go on for ever.

APPENDIX 'B'

SATELLITES OF THE EARTH

The first satellite is the moon, which has a diameter nearly 1/4th of that of the Earth i.e. a little over 2000 miles and is situated at a distance of 239,000 miles or 60 Mahāyojanas from us. Its mass is only 1/81 of that of the Earth, the latter being 5.87×10^{21} tons. It revolves round the Earth in a circular orbit and takes 27.3 days to complete the revolution. It is on this moon that the man has recently landed.

Till now people believed in only one moon of the Earth but it is not true. Lars Danielsson of the Royal Institute of Technology, Stockholm, Sweeden, and W. H. IP of the University of California, San Diego, U.S.A., have recently discovered the second moon of the Earth which has been named TORO. They computed TORO'S Orbit and found it to be in consonance with the Earth Moon system. Toro has a period of 1.6 years ; i.e., it takes 1.6 years to go completely round the Earth. At its closest approach it is at a distance of 12.2 million miles or 3000 Mahāyojanas from the Earth. Nobel Laureate Hannes Alfven and Gustaf Arrhenius, both of the University of California, San Diego (*Physics Today*, 24, 17) have suggested manned flights to the second moon for further investigation of the solar system.

This agrees quite well with the Jain view that there are two moons of the Earth.

The two suns :—According to Jain Cosmography there are two Suns in Jambū Dvīpa revolving round mount Sumeru[371]. Jambū Dvīpa literally means—a land of oval shape with a

371. मेरुप्रदक्षिणा नित्यगतयो नृलोके । (*Tattvārtha Sūtra*, 4·13)

bulge in the middle resembling a Jambolan fruit. Our Earth is a part of Jambū Dvīpa.

According to modern reckoning, our solar system is a part of a galaxy called the Milky Way. This galaxy is exactly of the shape of a Jambolan (Jambū Phal). The Solar System is composed of a Sun and nine planets. Out of these Jupiter with its thirteen moons is the most interesting and mysterious planet.

On March 2, 1972, a little spacecraft named Pioneer-10 was launched from America. Last December it flew past Jupiter and transmitted back to Earth a wealth of valuable information. After taking measurements of Jupiter's temperature, magnetic field, radiation belts, atmospheric composition etc. and using the data sent by Pioneer-10 the American astronomers have advanced the hypothesis that Jupiter was originally the little brother to the Sun.

(*The American Span*, *May* 1974)

The above view has been confirmed by recent theory of Dr. E. M. Drobyshevski of the Academy of Sciences of USSR published in *Nature* of 5th July, 1974 according to which Jupiter was originally in the centre of the solar system *and not the Sun*. This theory has succeeded in resolving a number of Astronomical riddles. Unlike the planets Mercury, Venus, and Mars which are solid, the Jupiter is made up of gases like hydrogen and helium akin to that of the sun. According to this theory sun and Jupiter formed a binary system in the beginning of the universe, the sun being evolved from the matter thrown out of Jupiter.—(Read the article 'Jupiter—A Dethroned King' published in *Science Today*, Sept., 1974).

The matter was referred to Dr. I. D. Serebreakov, Head of the Institute of Oriental Studies, Moscow (USSR) and the learned Dr. writes to inform us that the possibility of existence of such planetary systems (where two Suns rule movement of planets) is proved by astronomers.

He further adds: In some northern most area of our country some times, especially during severe frost (35°C—40°C below Zero), we can sea such interesting meteorological phenomena like a sun in two circles (see picture in the Frontispiece). But this phenomena is temporary like a rainbow.

The northern most region of USSR is arctic zone of the Earth which in the language of ancients is called the Sumeru (सुमेरु). In other words it means that the Phenomena of two Suns is seen round about Sumeru. In support of this view we quote the following verses from Siddhānta Śiromaṇi of Sri Bhāskarācārya.

लंकाकुमध्ये यमकोटिरस्याः प्राक् पश्चिमे रोमकपत्तनं च ।
अधस्ततः सिद्धपुरं सुमेरुः सौम्येऽथ याम्ये बडवानलश्च ॥
लंकापुरेऽर्कस्य यदोदयः स्यात्तदा दिनार्धं यमकोटिपुर्याम् ।
अधस्तदा सिद्धपुरेऽस्तकालः स्याद्रोमके रात्रिदलं तदैव ॥
(१, २)

(Lankā is situated in the centre of the Earth, to the east of it is Yamakoṭi, and Romaka Pattana in the west. Siddhapura is situated in the antipodes and Sumeru in the north.

At the time of sunrise in Lankā, it is noon in Yamakoṭi, sunset in Siddhapura and midnight in Romaka Pattana).